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XVI. *On the Fossil Mammals of Australia.*—Part I.   *Description of a mutilated Skull of a large Marsupial Carnivore* (Thylacoleo carnifex, Owen), *from a calcareous conglomerate stratum, eighty miles S.W. of Melbourne, Victoria.   By Professor* Owen, *V.P.R.S. &c., Superintendent of the Natural History Departments in the British Museum, and Fullerian Professor of Physiology in the Royal Institution of Great Britain.*

In a Report, No. X., on the Geology of the Basin of the Condamine River, by the Rev. W. B. Clarke, to the Honourable the Colonial Secretary of Australia, dated 14th October, 1853, is the following passage:—" It is probable that Mr. Stutchbury, whose studies in palæontology fit him for the search, will be so fortunate as to find the remains of an animal indicated by Professor Owen*, in the year 1842, of a carnivorous kind, for, as he says, 'some destructive species of this kind must have coexisted, of larger dimensions than the extinct *Dasyurus laniarius*, the ancient destroyer of the now equally extinct Kangaroo, *Macropus Titan*, &c., whose remains were discovered in the bone-caves of Wellington Valley.'   There were some fragments in the immense heap of osseous matter accumulated by Mr. Turner, which appeared likely to belong to such a carnivorous giant, but they were too small and imperfect to deserve conjectural description.   The discovery of what *must have existed* cannot be altogether incapable of demonstration, and, therefore, such a verification of Professor Owen's anticipation is to be hoped for on many grounds."—p. 6.

Now, although such verification has come to hand, I admit that the absolute terms in which the anticipation was expressed merit the mild rebuke implied by the italics in which those terms are emphasized in the quotation from the ' Report ' by the accomplished geologist of Australia.   Eighteen years of scientific experience have engendered a more cautious tone in referring to inductive probabilities.

The evidence of a large carnivorous marsupial, from pliocene formations in Australia, reached me not many years after my determination of the still larger herbivorous marsupial, *Diprotodon australis*†, which first suggested the idea of the coexistence.   That evidence was received in the year 1846 with the accompanying letter from my esteemed friend and correspondent Dr. Hobson, of Melbourne:—

* Letter to Editor of ' Annals of Natural History,' November 1st, 1842.

† Zoological Appendix to ' Mitchell's Three Expeditions into the Interior of Australia,' 8vo, 1838, vol. ii. p. 362.

" Bona Vista, New Melbourne, 25 January 1846.

" MY DEAR SIR,—I send you, by Captain BURRELL of the 'Achilles,' a box which contains some interesting fossil bones, from a lake eighty miles south-west of Melbourne. They were discovered and kindly forwarded to me by Mr. W. ADENEY, who has a sheep-station on the banks of the lake.   I have since visited the lake, which is called by the aborigines 'Colungoolac.'   It is very shallow, indeed almost dry in autumn, its muddy bottom being covered with a pretty thick deposit of common salt of excellent quality. This is the case in most of those in this part of Australia.   The whole of this part of the country is volcanic, and probably these salt lakes are the deeper parts of the ancient sea. There is one, however, called ' Parrumbat,' which appears to be the crater of an extinct volcano.   Its waters are from eighteen to twenty fathoms deep, with abrupt and almost perpendicular escarpments, except at two points, which appear to have been the outlets to streams of lava.   The sides are regularly stratified, and consist apparently of con-densed scoriæ.   The strata are singularly undisturbed and perfectly parallel, except in those places where large globular pieces of compact lava have fallen, and here their direction has been altered, as indicated in this rough diagram.
As these are some of the features of the country in which these bones are found, I think, perhaps, it may not be uninteresting to mention them.   The fragment of skull and incisor I hope may be new to you.

" I sent you about a year ago a box of the Mount Macedon fossils, by Captain FORDYCE of the brig ' Athens.'

(Signed)   " HENRY HOBSON."

The ' skull ' consisted of the cranial part (Plates XI. XIII. and XV. fig. 1), similar in size and in the development of the temporal ridges and fossæ to that of a Lion.   The ' incisor ' was a large tooth with a trenchant or incisive crown, implanted, with a small tubercular tooth, in a portion of the right superior maxillary bone, including part of the orbit and lacrymal bone (Plate XI. fig. 1, $p\,4$, and fig. 2).

The latter specimen gave decisive confirmation of the carnivorous character of the fossil, the ' incisor ' tooth ($p\,4$) answering in shape and function to the great sectorial or ' carnassial ' (Plate XV. fig. 4, $p\,4$), and the tubercular tooth (fig. 1, $m\,1$) to the small tubercular molar (fig. 4, $m\,1$) of the Lion*; being situated, as in that animal, on the inner side of the back part of the sectorial tooth.   Fortunately the nasal process of the maxillary in the detached facial portion of the skull of the *Thylacoleo* fitted a surface at the fore-part of the cranium in such a way as to demonstrate that it formed part of the same skull, completing the lower half of the orbit (Plate XI. fig. 1, o'), of which the upper half (o) remains in the cranial portion of the skull.

* The real homologies of these teeth can only be determined by specimens of young *Thylacoleo*, show-ing the order of development and change of the dentition : the symbols here only indicate the conformity of general shape and function to $p\,4$ and $m\,1$ in *Felis*.

The upper sectorial tooth of the fossil (Plate XI. figs. 1 and 2, p_4) is larger than that of the largest Lion or Tiger which I have seen, and than that of the great extinct Lion (*Felis spelæa*, Plate XIV. fig. 4, p_4). Its antero-posterior extent is 2 inches 3 lines, that in *Felis spelæa* being 1 inch 7 lines. The greatest diameter of the upper tubercular tooth (Plate XI. fig. 2, b), which is at right angles to that of the sectorial one, is $7\frac{1}{2}$ lines, that of the Lion (Plate XIV. fig. 4, m_1) averaging 6 lines.

The upper sectorial tooth of the Felines is divided into a 'blade' and 'tubercle,' the latter being developed from the inner side of the base of the fore-part of the crown, and being supported by a fang which makes an extension of the socket inwards at right angles to the rest of the socket. A portion of the fossil tooth has been broken away at this part (Plate XI. fig. 2, p_4), but apparently little more than the enamel; and the socket certainly shows no inward extension indicative of a 'tubercle' so large and distinct as in the Felines (Plate XIV. fig. 4, p_4): the crown of the sectorial in *Thylacoleo* is thicker here than in the rest of its extent, and has been slightly convex on the inside as on the outside of this part of the tooth; but there appears to have been no distinct lobe or tubercle, and I conclude that the crown of the upper great sectorial in the *Thylacoleo* consists exclusively of the 'blade.' The trenchant edge of this is not notched as in the Felines where it is trilobate (Plate XII. fig. 1, p_4), but is even and uniform, describing a very feeble concavity lengthwise (Plate XI. fig. 1, p_4). In the specimen it has been worn to a sharp edge by the play of the blade of a similar sectorial obliquely upon its inner side. The outer side of the crown is convex vertically, wavy lengthwise, being in this direction gently concave at the mid-part, convex at each end, with minor undulations of the surface near the base. The inner side of the crown is gently concave vertically at its mid-part, slightly undulated, but mainly convex lengthwise. The anterior border of the crown is formed by a subdentate ridge, sloping with a slight convexity downward and backward, in vertical extent 1 inch: the crown gradually decreases in this diameter to its back part, which ends in the form of a low protuberance. The tooth is strongly implanted by, apparently, an undivided base coextensive with the crown. I have not thought fit to mutilate the unique fossil to determine the depth and precise character of this implantation. The thickest part of the tooth is 8 lines.

The tooth which most nearly corresponds with the sectorial of *Thylacoleo* is the penultimate upper molar of *Sarcophilus* (*Dasyurus*) *ursinus* (Plate XIV. fig. 2). In this tooth the 'blade' forms the chief part of the crown; it is concave externally, convex internally lengthwise; its edge is entire, slightly concave; but it is associated with an anterior lobe and antero-internal tubercle, wanting in the fossil.

The tubercular tooth (*ib.* fig. 1, m, Plate XI. fig. 2, b) in *Thylacoleo* is on the inner side of, and at right angles with the sectorial tooth, but is almost half an inch in advance of the hind end of that tooth: in *Felis* (Plate XIV. fig. 4, m) it is close to that end. In *Thylacoleo* this tooth consists of a principal portion next the sectorial, and a small lobe (Plate XI. fig. 2, b) forming the inner or 'mesial' end of the crown: the principal part

rises to a low obtuse point, with a middle longitudinal depression between two convexities, on the outside: the inside slopes forward gradually to the base so as to represent, and act as, a crushing surface. Besides being relatively larger, this 'tubercular' tooth is more deeply and firmly implanted than in the Lion, whence is due its preservation in the present fossil, a circumstance which is very rare in *Felis spelæa*. In no Feline does this tooth present the accessory lobe, as in *Thylacoleo*. In the presence of this lobe at the inner end of the crown, the last small molar in *Sarcophilus* presents a closer resemblance to the same tooth in *Thylacoleo*; but the principal lobe is more pointed and trenchant in the small existing marsupial carnivore; and the whole tooth is so situated that its outer end is visible in a side view. The firm implantation of the last small molar, and its shape, are significant of the affinity of *Thylacoleo* to *Sarcophilus*.

In the Felines the outer wall of the maxillary above the socket of the sectorial tooth is perforated by the large antorbital foramen: it is not so perforated in *Thylacoleo*. The canal for the suborbital nerve and vessels is relatively smaller in *Thylacoleo* (Plate XI. fig. 2, *c*), and must open some way in advance of the socket of the penultimate tooth, as it does in *Sarcophilus*. From that socket to the orbit the outer surface of the maxillary is smooth and even, first gently concave, then as gently convex: it does not show the zygomatic protuberance which intervenes in *Sarcophilus*. The vertical extent of this part of the maxillary is 2 inches, being nearly the same as in the Lion. The border of the orbit is sharper and more produced, especially at the lower and fore part (*ib.* fig. 1, *o'*), than in the Lion.

Sufficient of the palatal part of the maxillary is preserved in this fragment to afford a very significant character of the nature and affinities of the *Thylacoleo*. In most *Marsupialia*, and in all the carnivorous species, the bony palate is interrupted by large vacuities opposite the antepenultimate and penultimate molars. In all placental *Carnivora* the bony palate is here entire; it shows, at least, only a small oblique nervo-vascular foramen at the suture between the palatine and maxillary; and the roof of the mouth is extended by bone some way behind the last molar tooth. In the present specimen of the *Thylacoleo* is preserved the smooth rounded outer border (Plate XI. fig. 2, and Plate XIV. fig. 1, *d*) of a large palatal vacuity opposite the hinder half of the penultimate tooth, and at a distance of 14 lines from it transversely. Such a vacuity extends opposite the penultimate and antepenultimate molar in *Sarcophilus* (Plate XIV. fig. 2).

I now proceed with the description of the larger, cranial, portion of the present fossil, before returning to another character in the smaller portion which I regard as decisive of its marsupial affinities. The cranial part of the skull shows a broad and low occipital surface (Plate XV. fig. 1); the sides (Plate XI. fig. 1) excavated by large temporal fossæ (27'), with their ridges meeting at a low and short parietal crest (Plate XVI. *t'*); the upper surface expanding, in front of this, to a very broad, almost flat interorbital region, 11. The post-orbital processes, 12, with the zygomatic arches, 27, and part of the basis cranii, are broken away. The extreme length of this portion of skull is 8 inches; the least breadth of the cranium, at the temporal fossæ, is 2 inches 2 lines.

The upper border of the occipital foramen (Plate XV. fig. 1) is as broad as in the *Felis spelæa*, and broader than in most of the existing species of Lion or Tiger; it does not present the pair of processes that characterize it in those large placental *Carnivora*. As the occiput rises from this border it slopes forward with a slight concave curve to the ridge, ₃, ₈ (Plate XIII. figs. 1, 3, 8), dividing the occipital from the upper plane of the skull: transversely the occiput is concave in the middle and slightly convex on each side, with a surface marked by musculo-tendinous insertions; the median depression is partly bisected by a vertical ridge (Plate XV. fig. 1, *f*), on each side of which there is a venous foramen. The breadth of the occiput on the level of the upper border of the foramen magnum is 5 inches; its height from the same border 2 inches 2 lines. In *Felis spelæa* the breadth of this part is 3 inches 4 lines; its height being 2 inches 8 lines. The *Sarcophilus* (Plate XV. fig. 2) much more nearly resembles the *Thylacoleo* in its low and broad occiput.

The major part of the basioccipital is broken away (Plate XIV. fig. 1); the anterior portion, which has coalesced with the basisphenoid (*ib.* ₅), forms with it, not a platform extending horizontally forward, as in placental *Carnivora*, but a bent surface forming a curve convex downward as it extends forward; this character is seen in the *Dasyurus macrurus* and in many Kangaroos; but the convexity at the junction of the basioccipital and basisphenoid, ₅, appears to have been greater in the *Thylacoleo*. The base of the left occipital condyle, ₂, remains; and in the fossa anterior to it, are the orifices of three precondyloid foramina (*g*), as in the majority of *Marsupialia*, including the *Dasyuri*; they unite to form a single hole internally in the *Thylacoleo*. In the placental *Carnivora* the precondyloid canal is single at both ends, and commonly opens externally into the jugular foramen (*Viverridæ, Hyæna, Felis*), or close to it, as in the Dog.

The jugular foramen (*i*) is bounded behind by a notch in the exoccipital, forming the margin turned towards the tympanic, ₂₈, and which margin is extended further in advance of the precondyloid foramina than in the Dog or any placental Carnivore in which those foramina do not communicate with the jugulars; in this respect the *Dasyuri* and many other marsupials resemble the *Thylacoleo*.

The bones composing the complex framework of the organ of hearing are strikingly different in the placental and marsupial *Carnivora*. In the Cat, Dog, Hyæna, Civet, Otter, Bear, the tympanic bulla is formed by the inflated petrosal with which the true tympanic bone has coalesced; in the marsupials the petrosal remains comparatively small, and is confined chiefly, if not wholly, to the function of a capsule of the internal organ of hearing; the tympanic bulla is excavated in the inflated base of the alisphenoid; and the tympanic bone itself continues a free and distinct ossicle, which, in the Dasyures and Thylacine, is a small thick semicylindrical canal with smooth obtuse margins, and its concavity looking backward and upward.

On the right side of the fractured base of the fossil skull in question, the small compact petrosal (Plate XIV. fig. 1, ₁₆) is exposed; it is similar to that in the *Dasyurus*, being grooved longitudinally at its inner and under side, the lower border of the groove forming a sharp edge, above which, on the inner side of the petrosal, the foramina

auditoria interna pierce the bone.   On both sides the tympanic sinuses in the alisphenoid, 6, are exposed; and their concordance with those in the *Dasyuri* is very clearly exemplified on the left side, in which the tympanic bone, 28, is preserved, showing its characteristic shape and relative position behind and external to the alisphenoid bulla, 6.

The canal of the meatus (*k*) external to the tympanic, is excavated in the outwardly produced base of the zygoma, behind the postglenoid process (*l*), for an extent resembling that in the *Dasyuri*, but much greater than in the Dog or other placental *Carnivora*.

Another character distinctive of the marsupial order is the position of the entocarotid canal (*m*), which perforates the outer and back part of the basisphenoid, 5 *: this orifice is lodged in a fossa between the basioccipito-sphenoid and the bulla auditoria in *Thylacinus* and *Dasyurus* (*ib.* fig. 2, *m*), and it presents exactly the same position, and perforates the same part of the basisphenoid, in *Thylacoleo*.

In the genus *Felis* the entocarotid enters the base of the skull at the fore-part of the *foramen jugulare*, notching the part of the petro-tympanic bulla at the fore-part of that foramen.   In the Hyæna, as in the Viverrines, the entocarotid notches or perforates the tympanic bulla in advance of the jugular foramen close to the side of the basi-occipital: it perforates the same part of the tympanic bulla in the Otter and other Mustelines.

The foramen ovale pierces the base of the alisphenoid immediately anterior to the bulla in the marsupial *Carnivora*, and is divided by a ridge from the carotid canal in the *Dasyuri*; it presents the same relations in *Thylacoleo* (Plate XIV. fig. 1, *n*), and the base of the ridge (*ib. s*) also remains to show the existence of that character.

The interval between the foramen ovale (Plate XI. fig. 1, *n*) and foramen rotundum (*ib. p*) is relatively much greater in the marsupial than in the placental *Carnivora*.   In the genus *Felis*, they are separated from each other only by the base of the ridge or rising of bone extending from the ectopterygoid towards the glenoid cavity, and the foramen is on the same transverse line with the anterior boundary of that articulation; in the Hyæna, Viverrines, and Dog, it is a little in advance of the same boundary; in the Otter it opens externally into a fossa common to it with the foramen lacerum anterius (or for. ophthalmicum).   In the Thylacine and Dasyures the foramen rotundum is distinct both within and without the cranial cavity from the foramen lacerum anterius, and is far in advance of the glenoid cavity.   It presents the same relative position in the *Thylacoleo* (Plate XI. fig. 1, *p*).

In *Felis* the foramen rotundum is larger than the foramen opticum; in *Dasyurus* it is much smaller; and this is the case also with the *Thylacoleo* (Plate XI. fig. 1), although the foramen opticum (*q*) is relatively smaller than in the *Dasyurus ursinus*.

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* "The carotid canals pierce the body of the sphenoid, as in Birds, and terminate in the skull very close together behind the *sella turcica*."—Zoological Transactions, vol. ii. (October, 1838), p. 390.   See also Mr. TURNER's careful and minute account of the "Foramina at the Base of the Skull" in Zoological Proceedings, May, 1848, p. 64.

In the marsupial *Carnivora* the basisphenoid is relatively longer than in the placental *Carnivora*, and, at its posterior part, it sends a ridge downwards from that part of each lateral margin which is not underlapped or covered by the base of the alisphenoid, the suture of which long continues distinct.   These ridges, with the alisphenoid, render the whole under surface of the basisphenoid canaliculate, or concave transversely: the basisphenoid is flat beneath in the placental *Carnivora*, and that part of the base of the skull is made canaliculate by the development of the ectopterygoid plate from the alisphenoid: these plates exist likewise in the marsupials, but, as they extend backwards to join the alisphenoidal bullæ, they diverge from the basisphenoid ridges and are external to them.

Sufficient of the base of our fossil skull remains to demonstrate this characteristic marsupial structure: the basisphenoid, though convex lengthwise beneath, is concave transversely by the production from the lateral margins of its hinder part of the same ridges (r, r) as those of the Thylacine and Dasyures, and in the degree of concavity more resembles the latter: the commencement of the outer ectopterygoid ridge (s) of the alisphenoid is preserved, diverging as it extends backwards from its anterior junction with the basisphenoid ridge.

The sutures between the alisphenoids and basisphenoid still remain, indicating the great antero-posterior extent of the former, and the degree to which they underlap the basisphenoid, leaving only a strip $2\frac{1}{2}$ lines broad exposed at its junction with the presphenoid, $_9$; and gradually diverging as they extend backward, the basisphenoid, $_s$, being one inch and a half in breadth at their hinder borders.

The characters of the base of the cranium here displayed by the *Thylacoleo*, and the greater retention of the typical elementary construction of the skull, would be sought for in vain in any mammalian *Carnivora*, save those of the marsupial order.

In the placental *Carnivora*, the superoccipital region, defined below by a boundary line drawn across the upper ends of the condyles, is almost as high as it is broad, and in rising from the foramen magnum it curves slightly backward.   In the marsupial *Carnivora* the same region so defined is much broader than it is high, especially in the Dasyures (Plate XV. fig. 2); in these the occiput is vertical; it inclines a little forward from the foramen magnum in the Thylacine.   All these characters are repeated in the *Thylacoleo*; the occiput being relatively as broad as in *Sarcophilus*, and the superoccipital sloping more forwards than in the Thylacine before it rises vertically to the occipital crest; thus departing in a greater degree from the placental type, and manifesting, as might be expected from the superior general size of the skull, in a more marked manner, the inferiority of development of the brain.   In every natural group or family of the warm-blooded Vertebrata the brain is proportionally less as the animal is larger, and its osseous case makes a smaller part of the entire skull.

In the marsupial *Carnivora* the brain is relatively much smaller than in the placental *Carnivora*, and the lateral walls of the cranial cavity make a smaller protuberance or convexity at the temporal fossæ.   In the remarkable skull under comparison, the sides of the cranial cavity make no protuberance whatever into the temporal fossæ; they have

been moulded solely in obedience to the pressure of the enormous temporal muscles, and present a uniform concavity towards the temporal fossæ. The cranial walls here (Plate XIII. fig. 1, 27′) show as little indication of the brain within as in a cold-blooded reptile: amongst the mammalian *Carnivora* the *Thylacoleo* is unique in this respect; and in the diminutive relative size of its cerebral organ, it is approached only by the Thylacine and the largest existing species of Dasyure.

In the *Das. ursinus* the apparent breadth of the cranial chamber is here greater than it actually is, by reason of the swelling out of the squamosal above the root of the zygoma through the extension therein of tympanic air-cells; and similar air-cells are exposed on the right side of the fossil *Thylacoleo* (Plate XI. fig. 1, *c*); but I know of no species of placental Carnivore in which the squamosal is so modified.

Another equally instructive marsupial character is exhibited by the bony outlet of a vein (ib. *s*), which conducts part of the blood from the lateral sinus to the outer and back part of the cranium: this venous foramen is situated behind the root of the zygoma and above the meatus auditorius in the Thylacine (Plate XII. fig. 2, *s*) and Dasyures. A similar diverticular vein is present in certain placental *Carnivora*, and has its external outlet behind the glenoid cavity and in front of the meatus auditorius, as *e. g.* in the Dog and Otter; there is a small venous outlet on the outside of the tympanic bulla in the Cat and Hyæna; but in no placental Carnivore is such a venous foramen present behind, or piercing the ridge continued backward from the root of, the zygoma.

In the *Thylacoleo* this venous foramen (*s*) is present in nearly the same relative position as in the marsupial *Carnivora*, posterior, viz., to the commencement of the ridge or hind root of the zygoma; in the Dasyure it is below the upper margin of the ridge; in the Thylacine it is posterior to the beginning of the ridge; in the *Thylacoleo* it is posterior and superior to the beginning of the ridge. Thus in the same degree in which the *Thylacoleo* departs in this particular from the largest existing marsupial *Carnivora*, it differs from the placental *Carnivora*, in all of which the foramen, besides its other differences of position, is quite below the zygomatic ridge in question.

The interorbital part of the upper surface of the cranium (Plate XIII. fig. 1, 11) is remarkable in the marsupial *Carnivora* for its great breadth, especially as compared with that of the cerebral portion of the cranium; the transverse diameter of this part at the middle and highest part of the upper border of the squamosals is, in the *Dasyurus ursinus*, less than half the same diameter of the narrowest part of the interorbital portion of the cranium. In the Tiger, Lion, and *Felis spelæa* the diameter of the interorbital space is one-seventh less than that of the cranium of the *Thylacoleo*, taken across the same part as in the *Dasyurus*. In the *Thylacoleo* the least diameter of the interorbital surface is 2 inches 10 lines; the diameter of the cranium opposite the middle of the upper border of the squamosals, 27′, is 1 inch 3 lines.

The broad interorbital platform of the *Thylacoleo*, with a broad and shallow depression, and two slight lateral convexities at its anterior half, passing posteriorly into an almost flattened surface, decreasing to the point where the temporal ridges (*t′*) meet above the

parietal, forms, in contrast with the contracted cerebral part of the cranium, a conspicuous marsupial character of the skull.

In the *Thylacoleo* the squamosal (Plate XI. fig. 1, 27) extends forward in the temporal fossa nearly half-way between the root of the zygoma and the postorbital process, and two-thirds of the way upward, 27', between the root of the zygoma and the parietal ridge; its contour is almost semicircular. In the Felines the squamosal extends a very little way, if at all, in advance of the base of the zygoma, and does not ascend half-way from that part to the parietal ridge (Plate XII. fig. 1, 27'). It is only in the marsupial *Carnivora* that we find those proportions of the squamosal which characterize the *Thylacoleo*.

On the inner wall of the right orbit the fronto-lacrymal suture shows that the lacrymal bone, 73, was of large size, that it formed the anterior half of that wall, and extended upon the upper part of the skull, forming apparently the anterior superorbital protuberance, besides extending forward upon the facial part of the skull, as far as that part anterior to the orbit has been preserved in the fossil. The lacrymal bone presents the same relative dimensions and extent in the largest existing *Dasyurus* (*D. ursinus*), in which the lacrymal duct pierces, not the orbital, but the facial, plate of the lacrymal bone, and is consequently outside the orbit.

In the Lion, the *Felis spelæa* (Plate XII. fig. 1), and other placental *Carnivora* in which the lacrymal bone is best developed, it is almost confined to the orbit, its most forward portion forming about the middle third of the anterior margin of the orbit, where it developes a slight protuberance; its orbital plate, moreover, does not attain that part of the inner wall of the cavity where it is so conspicuous in the *Thylacoleo* and *Dasyurus*, but extends backward along the lower part of the inner wall to join the orbitosphenoid. The lacrymal foramen, 73', is within the orbit.

The *Thylacinus* (Plate XII. fig. 2), which retains the marsupial proportions of the lacrymal bone, has an intraorbital perforation, besides two antorbital ones, 73': in most marsupials there are only the two antorbital lacrymal holes, and in the *Dasyuri* there is only one lacrymal foramen, which is outside and in front of the orbit; the *Thylacoleo* (Plate XI. fig. 1, 73') resembles the *Dasyuri* in its single antorbital perforation of the lacrymal bone, and this is one of the decisive marks of its marsupiality.

The postorbital process has been fractured on both sides; but on the left sufficient is preserved to show that the hind and front sides meet at a right angle, and form a ridge at its under part.

Sufficient of the articular surface (Plate XIV. fig. 1, s) for the lower jaw is preserved on the left side of the skull of the *Thylacoleo*, to show that it had a greater antero-posterior extent than in *Felis spelæa*, and was flatter at its fore-part, the margin there not being so produced: the same character is shown in *Dasyurus ursinus*. The post-glenoid process is fractured.

I am indebted to Mr. SAMUEL STUTCHBURY, F.L.S., for a cast of a portion of a right ramus of a lower jaw of a large Carnivore, a fossil which he obtained at Hodgson's Creek, Darling Downs, during his geological survey of that district of Australia in the year 1853.

This portion (Plate **XI**. fig. 3; Plate **XIII**. figs. 4 and 5) fortunately includes the carnassial and tubercular teeth, and by the correspondence of these in shape and size with the answerable teeth (p_4, m_1) in the upper jaw of *Thylacoleo* (Plates **XI**. and **XIV**. fig. 1), I believe it to belong to the same species.

The lower carnassial tooth consists only of the ' blade,' which is thickest anteriorly, with an even trenchant edge, describing a slight concavity lengthwise, and obliquely abraded by the play of the upper tooth upon the outer side of the edge. The outside of the tooth (Plate **XI**. fig. 3, p_4) is convex lengthwise, and also vertically at the fore-part: the inside (Plate **XIII**. fig. 4, p_4) is concave lengthwise, except near the fore-part; vertically it is convex at the base and concave above, the base being slightly grooved vertically. The anterior margin of the tooth, which is the highest, is bounded by a vertical ridge. The length of the crown is 1 inch 8 lines; the height at its fore-part is 9 lines; the thickness at the same part is 6 lines: the height and thickness of the crown diminish toward the back part. The small tubercular tooth (Plate **XI**. fig. 3; Plate **XIII**. figs. 4 and 5, m_1) is immediately behind the preceding: it consists, more distinctly than the one above, of an anterior principal lobe and a small posterior one; the anterior lobe is convex on both sides, subconical, with a worn obtuse summit. The antero-posterior extent of the crown is 7 lines; the same extent of both the teeth just equals that of the upper sectorial, and the lower tubercular is so situated as to play, in lateral movements of the jaw, upon the upper tubercular. Behind the tubercular in place there is the socket of a rudimental one, which cannot have exceeded 3 lines in its longest diameter (ib. m_2). From this socket the coronoid process begins to rise, sloping upward and backward. It is broken off within half an inch of its origin. The fore-part of the fossa for the implantation of the temporal muscle is preserved, showing by its depth the strength of that muscle; the anterior boundary of the fossa is vertical and convex forwards. The ramus of the jaw preserves the same depth from the last socket to the fore-part of that of the sectorial tooth. The symphysis (Plate **XIII**. fig. 4, s) begins behind, at a vertical line dropped from a little in advance of the middle of the sectorial, p_4; it is of a wide oval form. To judge from the cast, but little of the jaw appears to have been broken away from the fore-part of the symphysis. The upper and fore-part shows the alveolus and base of a tooth (Plate **XI**. fig. 3, c) which has projected obliquely upward and forward. It is separated by an interspace of 3 lines from the sectorial, and would seem to be the sole tooth in advance of it. If the ramus be really produced at the upper part of the symphysis further than is indicated by the present cast, it may have contained one or more incisors, and the broken tooth in question may be the lower canine. If, however, this be really the foremost tooth of the jaw, it would appear to be one of a pair of large incisors, according to the marsupial type exhibited by the *Macropodidæ* and *Phalangistidæ*. However this may ultimately prove to be, the molar series in each ramus of the lower jaw is reduced to the enormous sectorial and the two small tuberculars; and it would seem, therefore, in the upper jaw, to be reduced to the single sectorial and single tubercular on each side. It is possible that a canine

may have existed in the upper jaw as much longer and larger than that below, as the upper canine is in the extinct *Machairodus*. But sufficient is demonstrated in the above-described fossils to make known the most anomalous dental system in carnivorous Mammalia, whether placental or marsupial.

There is an interesting resemblance between the known dentition of the lower jaw of *Thylacoleo* and that of the small extinct mammal from the Purbeck strata called *Plagiaulax* by Dr. FALCONER *; and the resemblance would be closer should the broken tooth in the lower jaw of *Thylacoleo* here described prove to be the foremost one. Certainly no other known mammal shows two posterior tubercular teeth so similar to those in *Plagiaulax minor*, in their relative size to each other, to the trenchant tooth in front and to the ramus of the jaw, as does the *Thylacoleo*.

The anterior orifice of the dentary canal (Plate XI. fig. 3, *o*) appears, in the cast, to have been in the fossa, on the outside of the jaw, between the socket of the sectorial tooth and the one anterior to it. As much of the lower border of the jaw as is preserved is straight. Not enough of the back part of the jaw remains to indicate the form or direction of the angle. But the lower jaw of *Thylacoleo* must have been singularly short in proportion to its depth and breadth, and a like extreme shortness of the muzzle or facial part of the skull may be inferred.

With the above-described portions of the cranium of the *Thylacoleo*, I received from my friend Dr. HOBSON a portion of a sectorial tooth with one of the fangs. It was so similar in the character of the crown to the great sectorial in place, that I had no doubt about the genus to which it belonged, but only as to whether it was a smaller anterior sectorial of the upper jaw, or the sectorial of the lower jaw. Mr. STUTCHBURY's specimen has settled that doubt. The tooth (Plate XI. figs. 4, 5 and 6) is the hinder half, with the hinder fang of the left sectorial of the lower jaw. The characteristic markings and undulations or grooves of the enamel, and the thickness of this substance where it is exposed by the abrasion of the trenchant edge, are carefully shown in the figures.

In existing carnivorous mammals the ferocity of the species is in the ratio of the 'carnassiality' of the sectorial molar, *i. e.* of the predominance of the 'blade' over the 'tubercle;' and this ratio is shown more particularly in the upper sectorial, in which, as the tubercular part enlarges, the species becomes more of a mixed feeder, and is less devoted to the destruction of living prey. From the size and form of the carnassials of *Thylacoleo*, especially of the upper one, we may infer that it was one of the fellest and most destructive of predatory beasts.

The metacarpal bone (Plate XIII. figs. 6, 7 and 8) is here figured, as it resembles in its shape that of a large carnivorous animal, and may possibly belong to the *Thylacoleo*. The figures preclude the necessity of verbal description. It is from a freshwater deposit in Darling Downs, Australia.

On the occasion of a visit to London, in 1848, by the able comparative anatomist and palæontologist M. PAUL GERVAIS, at the period when the supposed marsupial character

* Proceedings of the Geological Society, March, 1857.

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of the *Pterodon* or *Hyænodon* of the Miocene deposits of Auvergne, Gard, and Vaucluse was under discussion, I took the opportunity to point out to M. GERVAIS certain characters deducible from the 'foramen caroticum' and 'foramen lacrymale' bearing on this question, and illustrated my conclusions by reference to the then unique carnivorous fossil which I had a short time before received from Australia.

The estimable author of the 'Zoologie et Paléontologie Françaises,' 4to, 1848–52, enters the genus *Thylacoleo* in the Table of Fossil Mammalia according to their geographical arrangement *; and in his remarks on those of Australia (Nouvelle-Hollande), he writes, "Ses dépôts pliocènes ou pleistocènes ont fourni des Grands Kangaroos, un grand Wombat †, diverses autres espèces congénères de celles d'à présent, les genres de *Diprotodon* et *Notothérium* qui étaient aussi des Marsupiaux, mais dont les allures et la taille approchaient de celles de nos grands pachydermes diluviens, et le Dasyurien, plus grand que le Lion, que M. OWEN nomme *Thylacoleo* ‡."

I cite this passage in testimony of the date of my determination of the marsupial nature of the great carnivorous Australian fossil, and of the imposition of its generic name; because the portion of the lower jaw with the carnassial and tubercular teeth of the same extinct species, which was obtained by my friend Mr. STUTCHBURY during the period in which he was fulfilling his valuable duties as "Geological Surveyor" of the colony of Australia, is alluded to under the name *Schizodon* in a Report to the Colonial Secretary, dated "Darling Downs, 1st October, 1853."

If this generic name had had priority of the one given by me to the same extinct genus, it must have been suppressed, since *Schizodon* had been previously applied in 1829 to a genus of fishes, which still retains it, by AGASSIZ §; to a genus of mammals by Mr. WATERHOUSE, in 1842; and, slightly modified as *Schizodus*, to a genus of mollusks by Mr. KING. Of course the two latter applications, like that by Mr. STUTCHBURY, must fall into the subordinate rank of synonyms.

The additional fossil of the *Thylacoleo* discovered by Mr. STUTCHBURY is a very welcome one. It was not, indeed, sufficient to guide the Colonial geologist to an idea of the order of *Mammalia* to which it belonged; and Mr. STUTCHBURY concludes his brief notice of the fossil by the remark, "Its affinities had better be left for future discussion, as it is probable that further search may bring to light more remains illustrative of this very singular animal ‖."

Such remains had, however, been obtained by Mr. ADENEY, and had been transmitted to me eight years previously; and the chief conclusion as to the affinities of the animal to which they belonged, had been indicated by the term *Thylacoleo*, i. e. Marsupial or

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* *Op. cit.* vol. i. p. 190.

† That, viz., which is alluded to as being "at least four times as large as either of the known existing species," in my Memoir on the existing Species of *Phascolomys*, of July 1845, Trans. Zool. Soc. vol. iii. p. 306.

‡ *Op. cit.* vol. i. p. 192.   § Selecta Genera et Species Piscium Brasiliensium, 4to, 1829.

‖ Papers relative to Geological and Mineralogical Surveys, 1853, p. 10.

Pouched Lion *, which conclusion was based on the characters and comparisons of those fossil remains detailed in the foregoing pages.

A desire to exhaust every needful and available subject of comparison has occasioned the long delay in communicating descriptions of the present selection of fossil remains of Australian Mammals.

The concurrence in them of so many cranial characters found only in the *Marsupialia*, will be deemed, I apprehend, demonstrative of the marsupial nature of the *Thylacoleo*; and, amongst existing *Marsupialia*, the *Sarcophilus* or *Dasyurus ursinus*—at present the largest existing species of its genus—seems to me to have the nearest affinities to the *Thylacoleo*, although the interval be still very great between them.

DESCRIPTION OF THE PLATES.

PLATE XI.

Fig. 1. Side view of the cranium and part of the upper jaw of the *Thylacoleo carnifex*:—nat. size.

Fig. 2. Inside view of part of the upper jaw, showing both the sectorial and tubercular molars of ditto.

Fig. 3. Outside view of part of the lower jaw of the *Thylacoleo carnifex*.

Fig. 4. Inside view of part of the left lower carnassial tooth of the *Thylacoleo carnifex*.

Fig. 5. Outside view of the same specimen.

Fig. 6. Upper view of the same specimen.

PLATE XII.

Fig. 1. Side view of the skull of the *Felis spelæa* (from European Bone-cave):—half nat. size.

Fig. 1 a. Outline of the sutures between the nasals, 15, and frontal, 11, and between the superior maxillary, 22, and the frontal, 11, showing the backward extension of the maxillaries, which distinguishes the Lion from the Tiger:—nat. size.

Fig. 2. Outline of the skull of the *Thylacinus Harrisii*:—nat. size.

PLATE XIII.

Fig. 1. Upper view of the cranium of the *Thylacoleo carnifex*:—two-thirds nat. size.

Fig. 2. Upper view of the cranium of the *Dasyurus (Sarcophilus) ursinus*:—nat. size.

Fig. 3. Upper view of the cranium of the *Thylacinus Harrisii*:—nat. size.

Fig. 4. Inside view of part of the lower jaw of the *Thylacoleo carnifex*:—nat. size.

Fig. 5. Upper view of the same fossil.

Fig. 6. Side view of a metacarpal of a carnivorous quadruped; from Australian pleistocene.

Fig. 7. Proximal end of the same.

Fig. 8. Distal end of the same.

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* From θύλακος, *marsupium*; λέων, *leo*.

PLATE XIV.

Fig. 1. Base view of the mutilated fossil cranium of the *Thylacoleo carnifex* :—nat. size.

Fig. 2. Base view of the cranium of the *Dasyurus (Sarcophilus) ursinus* :—nat. size.

Fig. 3. Base view of the cranium of the *Thylacinus Harrisii* :—nat. size.

Fig. 4. Part of the palate, with the sectorial (p 4) and tubercular (m 1) molars of the Lion (*Felis Leo*) :—nat. size.

PLATE XV.

Fig. 1. Occiput of the *Thylacoleo carnifex* :—nat. size.

Fig. 2. Occiput of *Dasyurus (Sarcophilus) ursinus* :—nat. size.

Fig. 3. Occiput of *Thylacinus Harrisii* :—nat. size.

Fig. 4. Occiput of *Felis spelæa* :—nat. size.

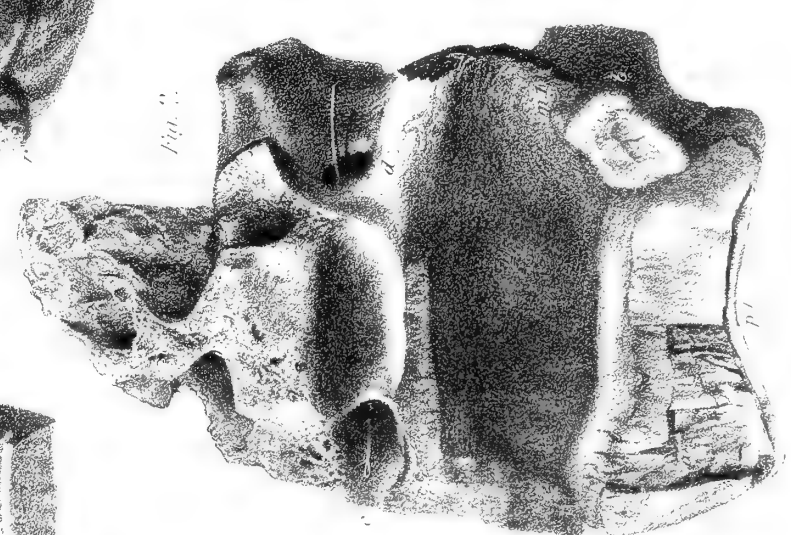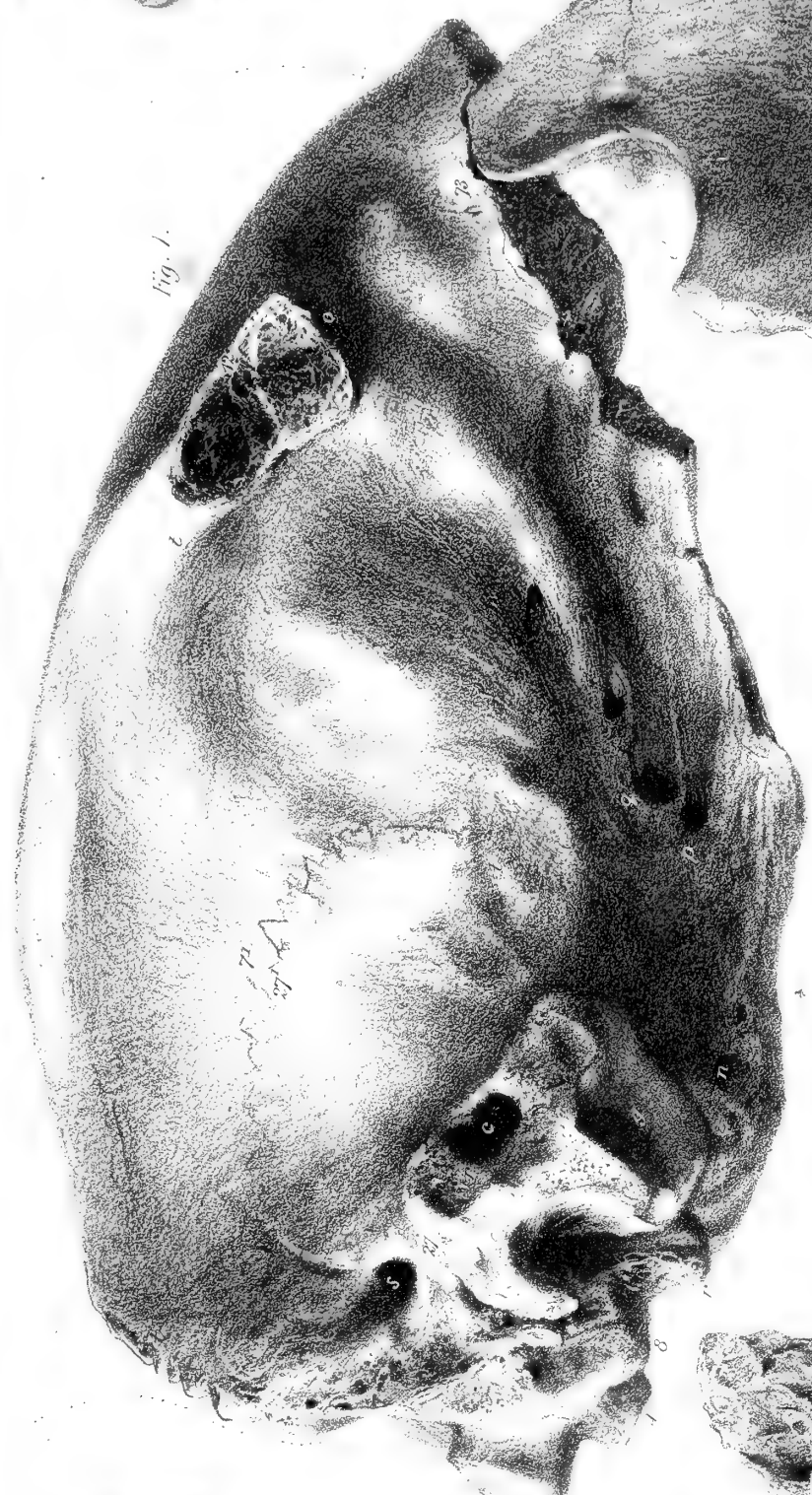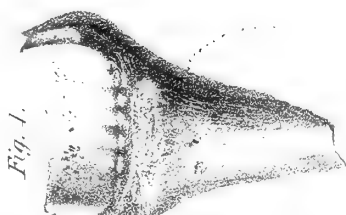The letters and figures are explained in the text.

Fig. 5.

Fig. 1.

Fig. 3.

Fig. 4.

Fig. 6.

Fig. 2.

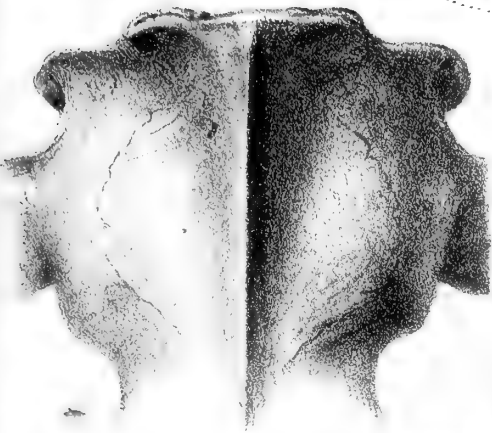Fig. 1.

Fig. 1ª
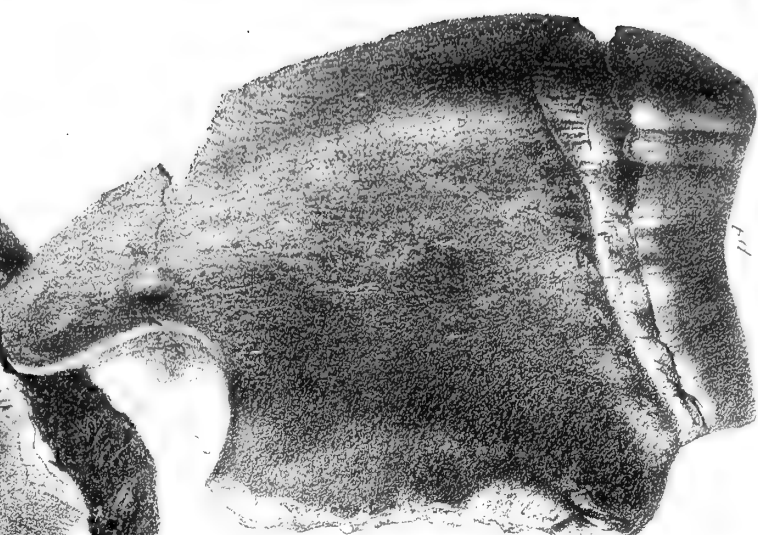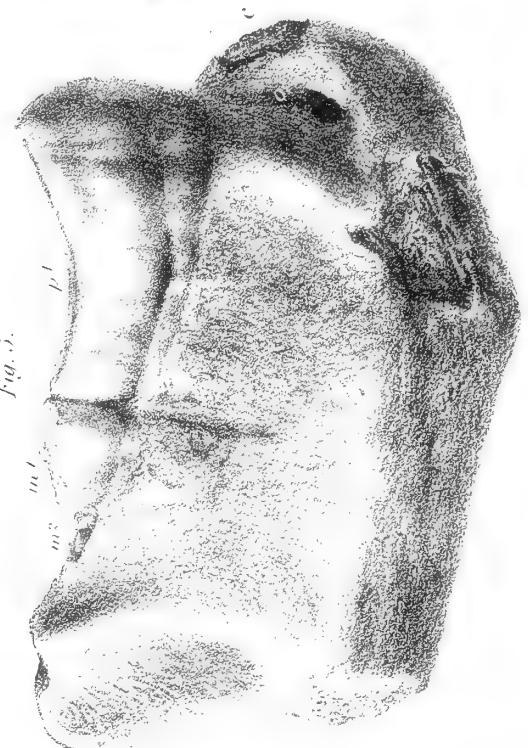
Fig. 2.

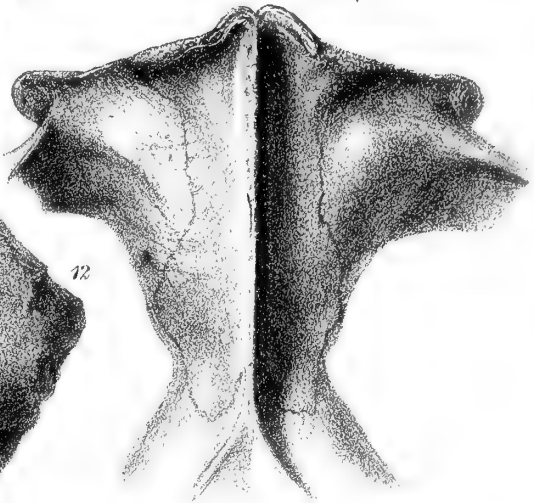Fig. 1.

Fig. 3.

Fig. 2.

Fig. 6.

Fig. 7.

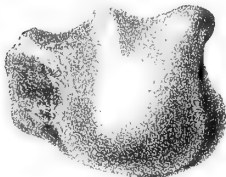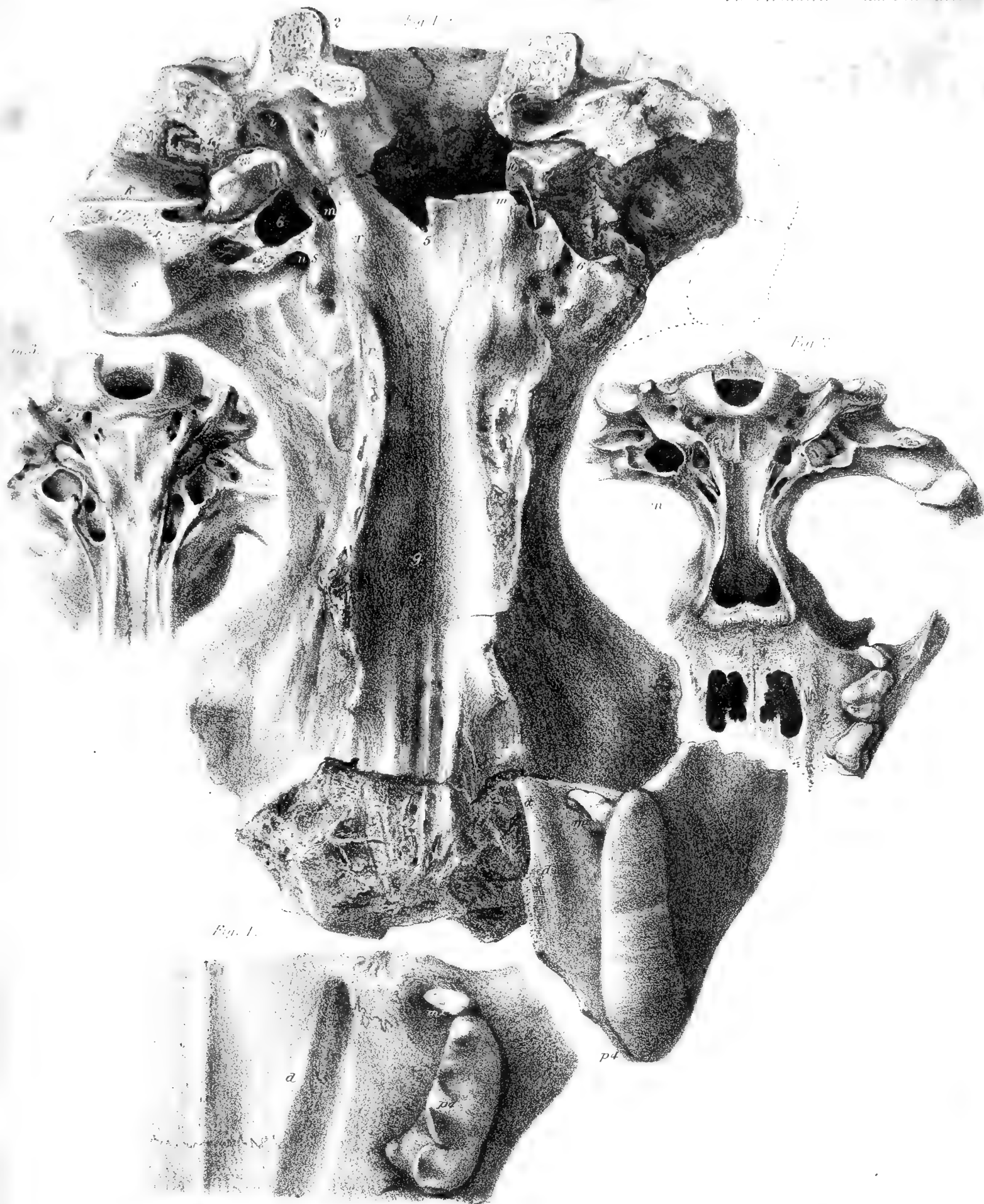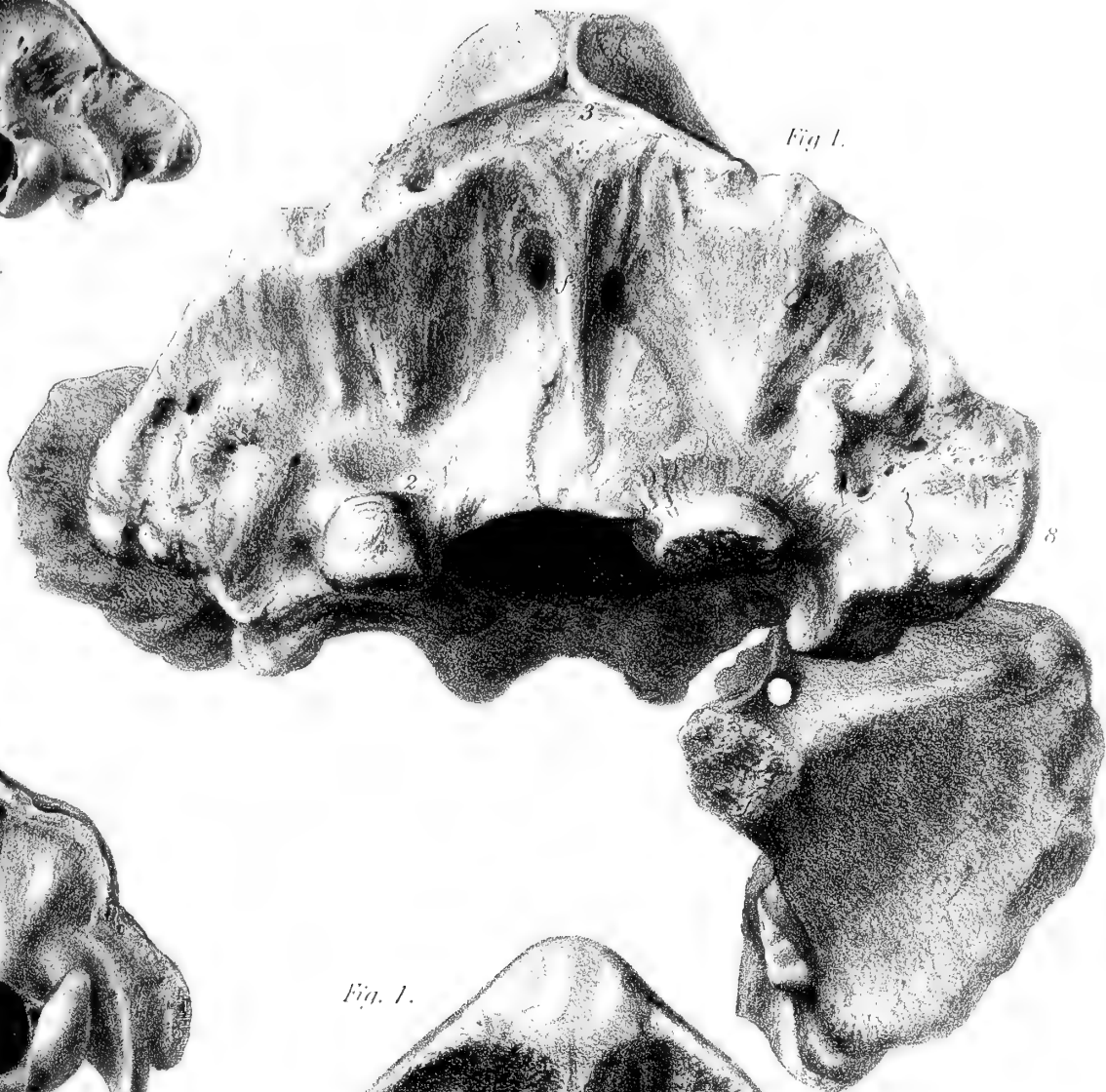Fig. 8.

Fig. 5.

Fig. 4.
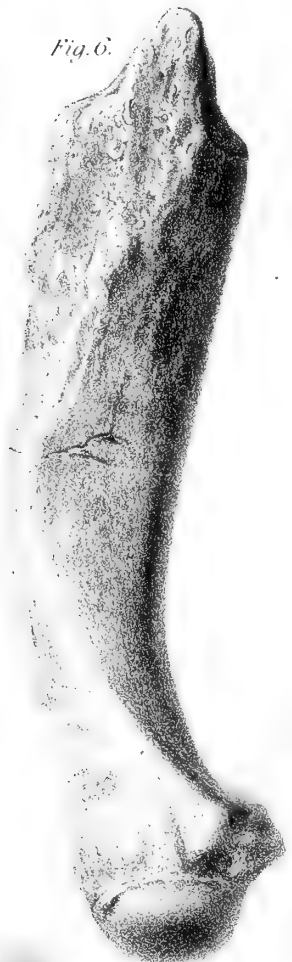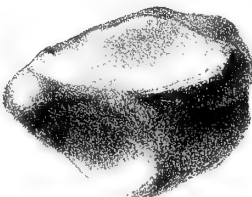
Fig. 2.

Fig. 1

Fig. 3.

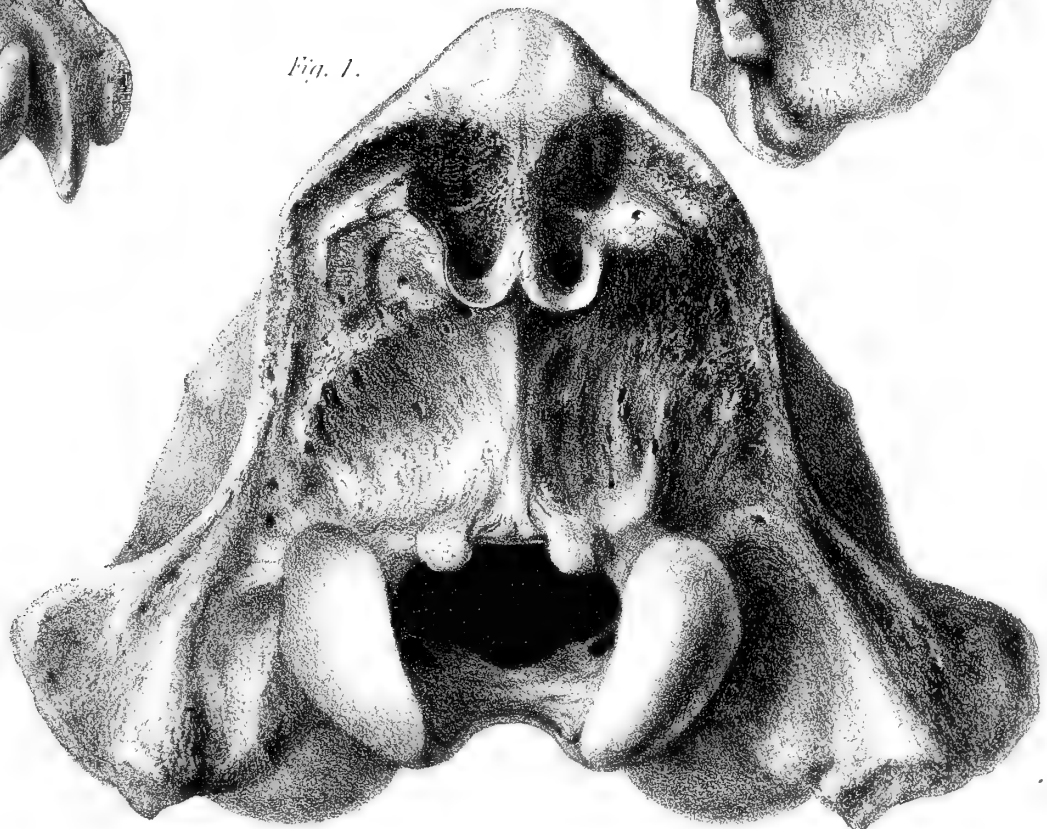*Fig. 1.*

IV. *On the Fossil Mammals of Australia.*—Part II. *Description of an almost entire Skull of the* Thylacoleo carnifex, Owen, *from a freshwater deposit, Darling Downs, Queensland. By Professor* Owen, *F.R.S., &c.*

I HAVE been favoured by EDWARD HILL, Esq., of Sydney, New South Wales, through the kind offices of his brother-in-law Sir DANIEL COOPER, Bart., with a small collection of fossil remains from that part of the freshwater deposits of Darling Downs through which the river Condamine has cut its bed.

Among these fossils were parts of a broken skull, at once recognizable, by its carnassial teeth, as belonging to the same large carnivorous marsupial as afforded the subject of Part I. of the present series of papers.

. On readjusting these fragments, I was gratified to find that they formed a more perfect skull than the one which first indicated the genus and species, and not only confirmed the marsupial character of the fossil, but supplied particulars of much value in determining the affinities of *Thylacoleo* in the marsupial series.

In previously reconstructing so much of the skull of the *Thylacoleo* as is figured in Plate XI. of the 'Philosophical Transactions' for 1859, I had, for the facial portion there preserved, only the guide of a small surface on the nasal process of a detached maxillary bone which fitted to about half an inch of the fractured surface of the fore part of the cranium. I was glad, therefore, to have the accuracy of that 'fit' confirmed by the more perfect state of the skull here described.

In comparing the upper carnassial tooth of *Thylacoleo* with that of *Felis* in my former paper, I had to regret that a fracture, with some loss of the tooth in the marsupial carnivore, prevented the precise determination of its degree of difference from that of the placental feline in regard to the " tubercular " part of the carnassial ; but a close inspection of the tooth in the fossil led me to infer that " little more than the enamel " had been broken away (p. 311). The perfect condition of both right and left carnassials at the fore part of the crown in the present instance (Plate III. p_4) enables me to state that, in the place of the tubercle, there is only a low vertical ridge of enamel, about a line in breadth, without any additional inner root at the fore part of the tooth : the large carnassial of *Thylacoleo* consists exclusively of the " blade." This is more worn than in the original specimen described. A smooth and polished surface is exposed by attrition, sloping from within downward and outward, and meeting the inwardly bent outer enamelled surface at an angle of about 50°. The worn surface is deeper at the fore and hind parts of the tooth than at the middle, agreeably with the antero-posterior concavity of the

outer surface. The hindmost part of the worn surface, which is 4 lines across, slopes rather outwardly from the rest, at a low angle defined by a linear boundary. I conclude that this surface is formed by the attrition of the small tooth succeeding the carnassial in the lower jaw, and marked $m\,1$, fig. 3, Plate XI. of the former paper. The more extended anterior surface indicates that the lower carnassials pass within the upper ones when the mouth is shut. The whole abraded surface shows a play of the teeth for trenchant action, like that of the blades of shears, in a more striking degree than in the carnassials of Felines. The fore part of the carnassial, here 7 lines in breadth at the base of the crown, is formed by a ridge of enamel, acquiring, as it approaches the working surface, a line in breadth; from this the crown quickly expands to its greatest breadth, which is defined by a similar vertical ridge on both the outer and inner sides of the tooth. The enamel tract between the anterior and outer ridges is convex; that between the anterior and inner ridges is flat. The outer surface of the enamel behind the ridge shows several slight linear vertical impressions, between which the enamel slightly bulges out, at the basal part of the crown, the grooves subsiding halfway toward the trenchant border; the enamel is also finely wrinkled. The vertical extent of the enamel decreases from the fore to the hind end of the crown. I have nothing more to add from this second specimen to the description of the upper carnassial of *Thylacoleo* given at p. 311 of my former paper. The breadth of the palate between the fore parts of the carnassials is 3 inches 5 lines, and between the hind parts 3 inches 10 lines; showing the slight convergence of the antero-posteriorly extended crowns of the carnassials anteriorly.

In the portion of upper jaw first described, the fore part had been broken away immediately in front of the alveolus of the carnassial tooth; but enough of the bone on the outer side of the socket remained to determine a differential character between *Felis* and *Thylacoleo* in favour of the marsupiality of the latter. From the state of the first specimen I could only say that the suborbital or antorbital canal "must open some way in advance of the socket of the penultimate tooth, as it does in *Sarcophilus*" (p. 312). The present specimen shows that the anterior opening of the canal (Plate III. 21) is about 3 lines in advance of the alveolus of that tooth (here the carnassial, $p\,4$), 10 lines above the alveolar border of the maxillary, and 6 lines behind the maxillo-premaxillary suture. The foramen is vertically elliptical, $3\frac{1}{2}$ lines in long diameter, and $2\frac{1}{2}$ in the opposite diameter. The corresponding foramen in *Felis Leo* may be 10 lines in long diameter and 6 lines in short diameter. This difference indicates the minor extent of sensitive surface and (vibrissal?) appendages in *Thylacoleo* as compared with *Felis*, and corresponds with the singular relative shortness of the muzzle in *Thylacoleo*, which the present instructive fossil exemplifies.

In this specimen the right occipital condyle is entire: it forms outwardly a strong oblique convexity, broadest above, contracting as it bends round the outside of the foramen magnum forward and inward; toward the foramen the condyle is slightly concave lengthwise (Plate III. 2). The lower ends of the condyles are about 5 lines apart, the

upper ends 1 inch 3 lines. The foramen magnum is 1 inch in transverse, and $7\frac{1}{2}$ lines in vertical diameter: it looks backward and a little downward. About 4 lines in advance of the foramen the basioccipital (Plate III. 1) begins to show a median longitudinal ridge, formed, or left apparently, by a pair of smooth excavations of this part of the under surface of the basi-occipito-sphenoid, the anterior half of which is bounded externally by the thick obtuse ridges developed from the sides of the basisphenoid (*ib.* 5). The depressions and dividing ridge are present, but more feebly marked in *Felis*; the basi-sphenoida ridges, which prolong backward the pterygoid walls (*ib.* 24) of the post-narial canal, are not developed in *Felis*: the breadth of the basis cranii between the tympanics is much greater in *Thylacoleo* than in *Felis*. The suture between the basioccipital and basisphenoid is obliterated. The pterygoids (*ib.* 24) are of great length; their bases almost meet beneath the presphenoid, but gradually diverge as they extend backward, uniting suturally with the sides of the basisphenoid as far back as the low thick ridges (*ib.* 5), which are the sole representatives of the "pterygoid processes" of the sphenoid. The bodies of the cranial vertebræ describe the same curve, convex lengthwise downward, as in the first specimen. The basisphenoid anterior to the median ridge is gently concave transversely, and this concavity becomes deepened by the junction of the ptery-goids, as the centrums advance, the pterygoid plates arching from the junction down-ward and outward, to form the sides of the posterior continuation of the bony nostrils or respiratory passage. The conformity in this part of the cranial structure of *Thyla-coleo* with that in *Thylacinus* (Phil. Trans. 1859, Pl. XIV. fig. 3) is very close.

The paroccipital (Plates II. & III. 4) is broken, but seems not to have extended far below the level of the occipital condyle; it articulates externally with the mastoid (8), which is not coextensive therewith vertically. Together they form a low, thick, obtuse, rough, subtrihedral pyramid, with the base downward and the outer side excavated.

The median vertical superoccipital ridge (Plate IV. fig. 2, 3) and the lateral depressions are better developed in the present specimen, with the more abraded carnassial teeth, than in the one first described; indicating the longer subjection of the bone to the action of the nuchal muscles.

The cranial nervures and vascular foramina are as in the first specimen, with which also the tympanic (Plate III. 28) agrees in its small size and relative position.

Nearly the whole of the articular surface for the mandibular ramus (Plate III. 27) is preserved on the right side of the present specimen; it is 1 inch 6 lines in transverse, and nearly 1 inch in antero-posterior extent; concave transversely, moderately convex from behind forward at its horizontal part; this facet changing or deepening to the concave only, where it is continued upon the post-glenoid plate: this is deeper than in the Lion, and much thicker; it is on the same transverse line as the tympanic, and is divided by the narrow fissure below the meatus auditorius externus from the mastoid.

There was sufficient of the articular surface in the first-described fossil to show that it had a greater antero-posterior extent than in *Felis*, with some minor characters of difference in which it more resembled that part in the Ursine Dasyure. So much of

this significant part of the skull being preserved in the present fossil as is formed by the zygomatic process of the squamosal demonstrates the wide difference from the semi-cylindrical transverse canal characteristic of the ginglymoid joint of the lower jaw in placental *Carnivora*. The surface, though of great transverse extent, was probably carried out further in that direction by the malar bone (to judge by the analogy of the *Dasyurus*, Philosophical Transactions, 1859, Plate XIV. fig. 2); but this part of the zygoma has been broken away. There is a striking similarity, indeed, in the kind of mutilation which the fossil skull from the freshwater deposits at Colungoolac (*ib.* p. 310), and that from the same formations channelled by the Condamine, has undergone. The occipital condyles, zygomatic arches, and postorbital processes have suffered, differing only in the degree in which these projecting parts have been broken away during the apparently similar cosmical violences to which both fossils have been subject. Besides the post-glenoid ridge (Plates II. & III. *l*) in *Thylacoleo*, there is a narrower boundary wall descending in the inner or mesial end of the articular surface, nearly as low as the posterior one; it renders the surface concave in the transverse direction; and against this " entoglenoid process" (ib. *e*) abuts the apex of a thick obtuse triangular mass of bone, with the base turned toward the descending basisphenoid ridge, but separated from it and from the end of the pterygoid by a groove. This convex portion of bone (Plate III. *6*) appears to be developed from the base of the alisphenoid, and to have contributed to the tympanic cavity, like the second "bulla ossea" in *Perameles**; it was broken away on both sides in the first-described skull, but the pneumatic cavity by which it was excavated is partly shown on the left side (Philosophical Transactions, 1859, Plate XIV. *6*); its base is perforated by the "foramen ovale."

In the present skull the cranium has been broken across lengthwise, and almost horizontally, exposing the extension of the air-sinuses (Plate IV. fig. 4) from the nose to the occiput, raising the outer table of the cranium nearly 2 inches above the inner one at the middle of the intertemporal ridge, and showing the small cerebral cavity restricted to the lower and hinder half of the cranium. The length of this cavity is 4 inches, its breadth 3 inches, its height 2 inches. Neither falx nor tentorium was ossified. The anterior boundary of the "sella" is indicated by a transverse rising produced into a pair of small retroverted "clinoid" processes, but there is no depression below the level of the cranial surface of the basisphenoid. The rhinencephalic compartment is relatively large.

In all the characters of the cranium shown and described in the original specimen the present fossil corresponds therewith. The posterior palatine vacuity, indicated by the smoothly convex inner border of the roof of the mouth parallel with the hind half of the sectorial tooth (in Plate XIV. fig. 1, *d*, *tom. cit.*), is shown in the present skull (Plate III. *d*) to be the fore part of the wide and advanced " palato-nares;" they are divided, mesially, by the presphenoid rostrum and vomer, and are bounded, laterally, by an extension of the palatal process of the maxillary and of the palatine to the ptery-

* Cyclopædia of Anatomy and Physiology, vol. iii. Art. *Marsupialia*, fig. 96.

goid. This extension (*ib.* ⁳₉), flat below, convex above, contracts to a diameter of eight lines opposite the middle of the posterior nostril, then increases in breadth, and loses in depth as it passes into the pterygoid wall of the wide and deep pterygo-sphenoid basi-cranial longitudinal median canal. Each posterior bony nostril is longitudinally ovate, with the great end forward, 2 inches in longitudinal and rather more than 1 inch in transverse diameter; with the plane of the opening inclined from without upward and inward, and, more feebly, from before upward and backward. The bony roof of the mouth is thus much reduced in length; a dimension which is surpassed by its breadth between the great carnassial teeth. Its posterior border is thin, and sharp where it forms the fore part of the palatal nostril, and gradually thickens, becoming smoothly convex at the outer side of that aperture. The bony palate is perforated by a pair of apertures about 1 inch in advance of the hind border, and 1½ inch from the anterior end; that on the left side (Plate III. *a*) is elliptic, about 5 lines by 3 lines in its two diameters; on the right side the bony palate is partly broken away: these answer to the incisive or pre-palatal foramina, and are on the line of the suture of the premaxillary with the max-illary palatal processes. The breadth of the palate, which is nearly 4 inches between the hind ends of the carnassials, is reduced to 1 inch 3 lines anterior to the small open-ings above-mentioned, and rapidly contracts to a breadth of 3 lines between the large sockets of the anterior teeth, which here, descending, convert the fore part of the palate into a deep groove.

The most welcome and instructive part of the present fossil skull is the fore part, giving evidence of the anterior teeth, and of the formation, position, and aspect of the external nostril. This orifice (Plate IV. fig. 1) is formed by the premaxillaries (₂₂) and extremities of the nasals (₁₅). A characteristic of most of the facial sutures in *Thylacoleo* is their finely undulated or subdentate structure. This is shown between the maxillary (Plate II. ₂₁) and malar (₂₆), between the maxillary (₂₁) and premaxillary (₂₂), and between the nasals (₁₅) and premaxillaries; though not in the median suture between the nasals themselves. These bones (Plates II. & IV. figs. 1 & 3, ₁₅) slightly expand at their fore ends, where their free margin is thick and obtuse, and forms the upper third of the ex-ternal nostril. The premaxillaries form the sides of the opening by a similar margin, which rapidly expands at the lower half, to form or be continued, sloping forward, into the alveoli of the pair of incisor tusks (*i* ₁). The inner or medial border of each alveolar outlet (Plate III. *i* ₁) is continued downward below the level of the contiguous bony palate for about 4 lines, forming the sides of a groove or canal at that part about 3 lines in breadth, which expands as the palate extends backward between these alveoli. At the middle of the lower boundary of the external nostril the premaxillaries rise into a slight prominence; the lateral borders of the nostril are slightly concave vertically (Plate II. ₂₂); the form of the nostril (Plate IV. fig. 1) is transversely elliptic; its plane almost vertical, with the lower border a little advanced; the anterior margin of the nasals is, through fracture, not quite entire. The vertical diameter of the nostril is 1 inch 2 lines, the transverse diameter 1 inch 10 lines. The vertical extent of the premaxillary is

2 inches 7 lines; the antero-posterior extent of the upper part of the premaxillary, or of the naso-premaxillary, suture (Plate III. between 15 & 22) is 2 inches; the maxillo-premaxillary suture (*ib.* between 21 & 22), as it descends, runs forward, reducing that dimension of the bone at the middle of the nostril (22) to 1 inch, whence it expands to 1 inch 8 lines, where it contributes to the alveolar border of the upper jaw and to the bony palate; the pair of incisive or premaxillary palatal foramina, before described (Plate III. *a*), open upon the suture of the premaxillary with the palatal plate of the maxillary.

Each premaxillary has three alveoli; the outlet of the foremost (Plate III. *i* 1) is oval, with the larger end forward, 1 inch in long diameter, $7\frac{1}{2}$ lines across the widest part: this socket rises for nearly 2 inches in the substance of the bone, inclining a little backward and outward to its closed end; the long axes of the outlets converge forward. The outlet of the second incisor (ib. *i* 2) is a full ellipse, 4 lines by $3\frac{1}{2}$ lines in the two diameters; that of the third incisor (ib. *i* 3) seems to have been of similar size. The breadth of both premaxillaries posteriorly is 2 inches 10 lines; anteriorly, across the first alveoli, 1 inch 8 lines; the length of the premaxillary part of the bony palate is 1 inch 7 lines. The maxillary (Plate II. 21) swells outward as it leaves the premaxillary to form the socket of the great carnassial (*p* 4), above which it rises to join the malar (26), the lacrymal (13), the frontal (11), and the nasal (15) bones. Anterior to the root of the carnassial it is perforated by the small antorbital foramen. Behind the carnassial socket the bone extends outward and backward for $1\frac{1}{4}$ inch, forming the lower and fore part of the temporal fossa, and there terminating by a free obtuse convex border (*ib.* 21′), of similar vertical extent, below the malo-maxillary suture. The corresponding part of the posterior border of the maxillary in *Felis* is concave. On the inner side of the hinder end of the carnassial socket is that (Plate III. *m* 1) for the small tubercular tooth, which was preserved in the first described specimen; the long axis of its outlet forms an open angle with that of the carnassial socket, at the fore part of which the alveolar border of the maxillary is excavated by either a similar socket for a two-rooted tooth, or by two contiguous sockets for two small single-rooted teeth (ib. *p* 3). I think the first the more likely explanation, in which case the long axis of the outlet of this socket forms an open angle with that of the carnassial one, extending therefrom inward and forward, instead of inward and backward, like the posterior socket. The extent of such axis is 6 lines, the first subcircular orifice being rather less, the next rather more than 3 lines in diameter. The fore part of this socket is near the lower end of the maxillo-premaxillary suture, and the state of the alveolar and contiguous palatal part of the jaw here precludes any clear determination relative to a canine; such a tooth (ib. *c*), of small size, conical and obtuse, had been cemented to this broken part of the alveolar border, in the line of the small posterior incisors.

The posterior part of the maxillary is concave as it rises from the border to form the fore part of the temporal fossa, and then bulges out into that fossa as a smooth convexity, on the inner side of which is the hinder opening of the suborbital canal (Plate IV. fig. 3, *o*). Above this convexity the lower and fore part of the orbit impresses that

part of the maxillary which supports the lacrymal, which forming that part of the rim of the orbit and extending backward adds to the depth of the depression.   The rim subsides above the lacrymal, and the upper part of the orbit is continued convexly upon the upper part of the skull parallel with the posterior ends of the nasals and contiguous part of the frontal (*ib.* 11).   The superorbital ridge is resumed by the outstanding and down-bending process of the frontal (Plate II. 12), which, being broken away on both sides of the skull, exposes the large air-sinus with which it was excavated.   The rimless upper part of the orbit is 10 lines in extent.   The orbit is relatively smaller than in *Felis*, deeper anteriorly, and more significantly different by its wall not being pierced for the lacrymal canal, the entry of which (*ib.* 13) is situated externally, as shown in the first-described specimen of *Thylacoleo*.   The length of the nasal bones (Plate IV. fig. 3, 15) is 3 inches 6 lines ; their least breadth, conjointly, is 1 inch ; they slightly expand at both ends, but most so posteriorly, where they are 2 inches across.   Their median suture remains; that of the frontals is in great part obliterated, and the conjoined frontals (*ib.* 11) enter the posterior interspace of the nasals.   The fronto-nasal suture is undulatory.   The nasal processes of the maxillaries do not extend so far back as the nasals, which terminate angularly, but with the apex largely rounded off.

The upper cranial surface of the frontals (Plate IV. fig. 3, 11) contracts backward to the intertemporal ridge (ib. *t*); the boundary between frontal and parietal is not shown. At the anterior expanded part of the frontals the external surface forms a pair of low convexities divided by a median longitudinal shallow channel, but deeper and with the convexities better marked than in the first specimen.   These convexities give a contour line to the upper part of the skull (Plate II.), resembling that in the Brown Bear, which also the skull resembles in the breadth of the naso-maxillary part.   The upper and hinder parts of the cranium correspond with those which were characterized in the former paper.

The dentition of the upper jaw, as indicated by alveoli in the present specimen, includes, on each side, three incisors (Plate III. *i*, 1, 2, 3), followed by three or four other teeth: of these, one is the great carnassial (p 4), another, the small transversely-oblong tubercular (m 1): the seat of doubt is between the carnassials and incisors.   To one of the doubts expression has been already given; whether, viz., the carnassial was preceded by one small two-rooted premolar (p 3), or by two smaller and single-rooted teeth.   A canine appears to be represented by the tooth with a subcircular, conical, obtusely worn crown, under 3 lines in diameter, supported on a thicker base (ib. *c*). Future specimens may clear up this part of the dentition of *Thylacoleo*.   It is certain that the anterior incisor (ib. *i* 1) bore a relation of size to the carnassial similar to that of the canine tusk in *Felis* to the carnassial.   Of the two small premaxillary teeth which succeeded the front tusk, neither is preserved,

The size of the laniary canine in *Felis* being here transferred to the first incisor, its function as killer was similarly provided for by its approximation to the moving power, through the extreme shortness of both upper and lower jaws, especially anterior to the

chief molar teeth. In *Felis* the small incisors are very little in advance of the canine; this large tooth is almost at the fore part of both upper and lower jaws; and in *Thylacoleo* the relative position of the incisor-tusk to the enormous temporal fossa is such as to give it the advantage of a harder or closer grip during the action of the powerful temporal muscles.

In the former paper so much of the characters of the lower jaw, and its teeth, of *Thylacoleo* were given as could be deduced from the cast of a portion of that bone figured in Plates XI. & XIII. figs. 3, 4, & 5, pp. 317 & 318, of the Philosophical Transactions for 1859.

The carnassial and succeeding tubercular teeth, being in place, served to refer this fossil to the same species as that indicated by the upper jaw (Plate XI. figs. 1 & 2, *tom. cit.*). A socket for a second smaller " tubercular " was evident, behind the one in place. The chief doubt remained in regard to the fore part of the mandibular ramus; the plaster-cast did not admit of any certain conclusion as to the extent to which the original might there have suffered fracture; part of the symphysial surface and the base or socket of a large obliquely produced tooth could be made out, and this " seemed to be the sole tooth in advance of" the carnassial. Accordingly I wrote, " If the ramus be really produced at the upper part of the symphysis further than is indicated in the present cast, it may have contained one or more incisors, and the broken tooth in question may be the lower canine. If, however, this be really the foremost tooth of the jaw, it would appear to be one of a pair of large incisors, according to the marsupial type exhibited by the *Macropodidæ* and *Phalangistidæ*" (*loc. cit.* p. 318).

The perfect condition of the upper jaw of the chief subject of the present paper determined the alternative, and proved the *Thylacoleo* to be the carnivorous modification of the more common and characteristic type of Australian Marsupials, having the incisors of the lower jaw reduced to a pair of large, more or less procumbent and approximate, conical teeth or " tusks."

I have been favoured by Mr. GERARD KREFFT, the able Curator of the Australian Museum, Sydney, New South Wales, with a " photograph " of the outer side, and an outline sketch, natural size, of the inner side, of a portion of the right mandibular ramus of *Thylacoleo carnifex* in that Museum, which presents the same general resemblance, in the kind and degree of mutilation, to the original of the cast described in Part I., which the cranium from the " Condamine River " presents to the one from " Colungoolac." It is fortunately, however, a little more complete; sufficiently so to demonstrate that the large socket (Plate IV. figs. 5 & 6, *i*) is of the foremost tooth of the lower jaw. It also exhibits two small approximate alveoli, or the divisions of an alveolus, for a two-fanged tooth, corresponding in size and in relative position to the carnassial, with the similar socket or sockets noticed in the description of the upper jaw (Plate III. *p* 3). There are evidently no smaller incisors behind the large one of the lower jaw, nor any other teeth between the large incisive tusk and the small tooth or teeth on the inner side of the fore part of the great lower carnassial. The portion of

lower jaw in the Sydney Museum also shows the socket for the minute tubercular tooth (Plate IV. figs. 5 & 6, m_2) behind the posterior double-rooted one (*ib. m* 1). The " foramen mentale," the anterior boundary of the depression for the insertion of the large temporal muscle, and the form of symphysis, closely resemble all these characters as shown by the cast of the mandible first described. Mr. KREFFT has dotted the depth to which the socket of the lower incisive tusk descends in the symphysial part of the jaw (*ib.* fig. 6, *i*): it is somewhat greater than that of the upper tusk.

The length of the dental series of the upper jaw, in a straight line, is 4 inches 3 lines; that of the lower jaw is 3 inches 3 lines.

From present data the probable formula of *Thylacoleo* is:—$i\frac{3-3}{?}, c\frac{1-1}{?}, p\frac{2-2}{2-2}, m\frac{1-1}{2-2}=24$. Of the incisors of the upper jaw, the first is a large tusk; of the premolars, the first is small, probably two-fanged, the second a very large carnassial. The first molar is small and two-fanged in both jaws, the second is restricted to the lower jaw, is still smaller, and is single-rooted. The chief business of the teeth has been delegated to the tusks and carnassials; development has been concentrated on these at the cost of the rest of the normal or typical dental series. The foremost teeth seized, pierced, lacerated or killed, the carnassials divided the nutritive fibres of the prey.

Thylacoleo exemplifies the simplest and most effective dental machinery for predatory life and carnivorous diet known in the Mammalian class. It is the extreme modification, to this end, of the Diprotodont type of *Marsupialia*.

Besides the full confirmation which the additional fossils, here described, give of the marsupiality of *Thylacoleo*, its closer affinities in that Order are shown to be, not to the existing Carnivorous Marsupials, e. g., *Sarcophilus*, *Dasyurus*, *Thylacinus*, *Didelphys*, but to the Diprotodons, Nototheres, Koalas, Phalangers, and Kangaroos. It may, I think, be said that the skull above described is one of the most singular and interesting mammalian fossils hitherto discovered.

Admeasurements of the Skull.

	in.	lin.
Length	9	8
Length of the facial part anterior to the orbit	3	0
Breadth at the preserved posterior part of the zygoma	7	2
Breadth at the preserved anterior root of the zygoma	6	9
Breadth of the cranium between the temporal fossæ	2	3
Length of the bony palate, from the fore border of the palato-nares	2	11
Breadth of the bony palate at the same part	3	6
From the fore end of premaxillary to the hind border of the palato-nares	4	9
From the hind border of the palato-nares to that of the occipital condyles	5	6
Length of the temporal fossa, including the orbit	7	2
Breadth of the interorbital space across the antero-superorbital ridges	3	10
Breadth of the interorbital space behind the antero-superorbital ridges	3	0
Least breadth of the foramen magnum	0	11

	in.	lin.
Least height of the foramen magnum	0	7
Breadth between the upper ends of the condyles	1	4
Breadth across the broadest part of the condyles	2	5
Breadth across the paroccipitals.	4	2
Breadth across the mastoids	5	3

Vertical diameter, or depth of the upper jaw, at and including the fore part
of the carnassial tooth 4 0

Vertical diameter, or depth of the mandible, at and including the fore part
of the carnassial tooth 3 0

Other admeasurements are noted in the text.

DESCRIPTION OF THE PLATES.

PLATE II.

Side view of the skull, without the mandible, of the *Thylacoleo carnifex*:—nat. size.

PLATE III.

Base view of the skull of the *Thylacoleo carnifex*:—nat. size.

PLATE IV.

Fig. 1. Front view of the skull of the *Thylacoleo carnifex*.

Fig. 2. Back view of the same skull.

Fig. 3. Upper view of the same skull.

Fig. 4. Air-cells of the diploë above the cavity for the brain.

Fig. 5. Outer side of part of the right mandibular ramus, with the carnassial (p_4) and
first molar (m_1).

Fig. 6. Inner side of the same portion of mandible: the second molar (m_2) and the
incisive tusk (i) are indicated in outline.
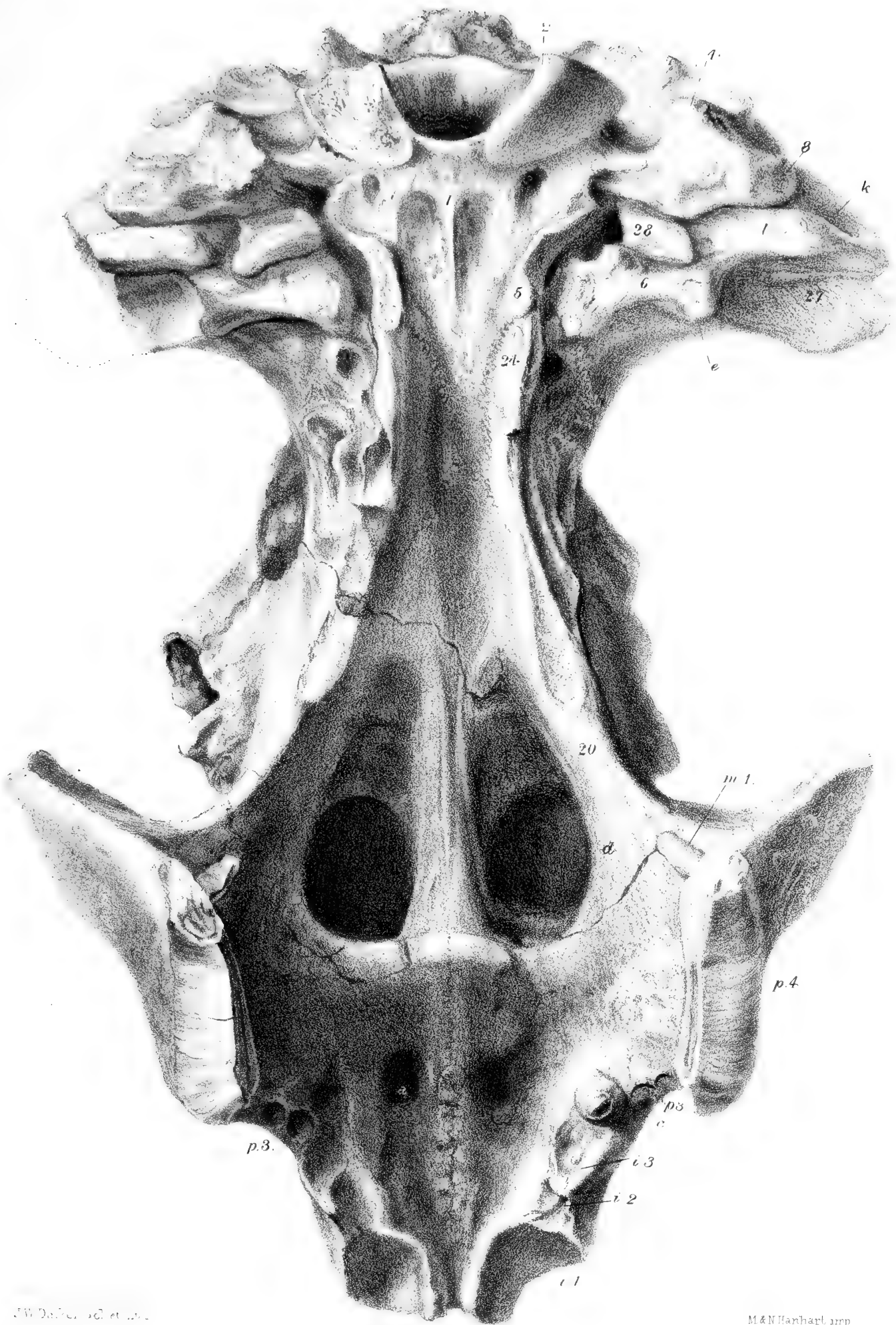
All the figures in this Plate are half the natural size.

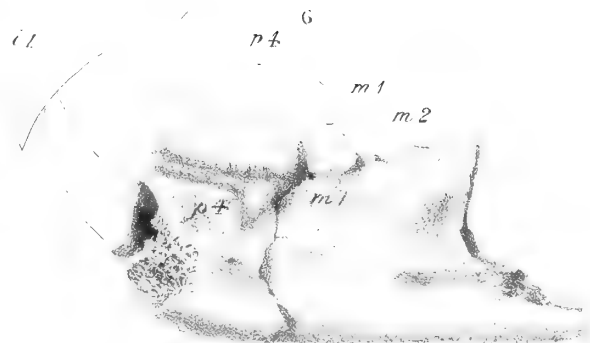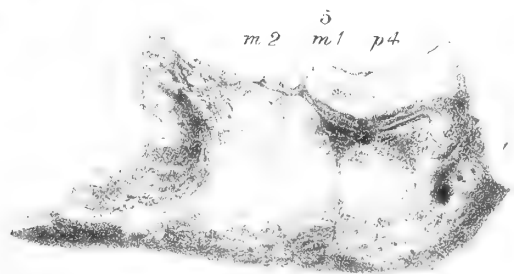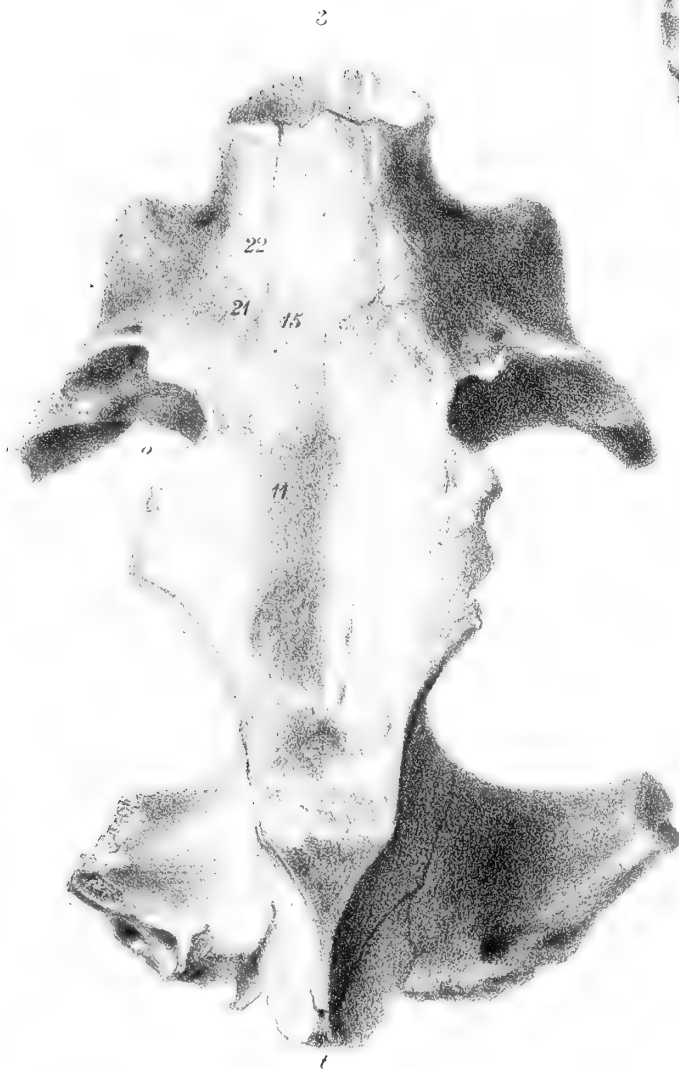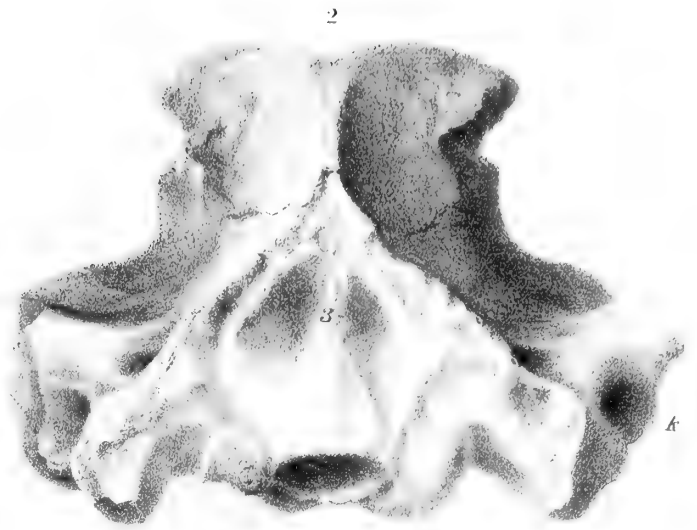The letters and figures are explained in the text.

[519]
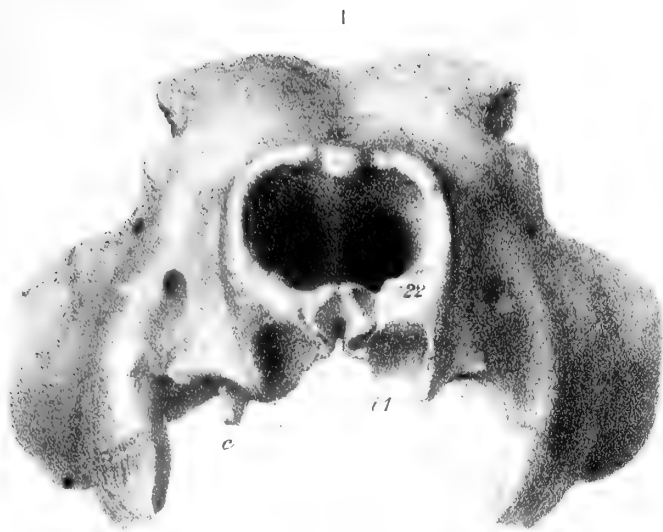
XXIII. *On the Fossil Mammals of Australia.*—Part III.   Diprotodon australis, Owen.
By Professor Owen, *F.R.S. &c.*

§ 1. *Introduction.*—In a letter dated May 8th, 1838, addressed to Sir Thomas Mitchell, F.G.S., Surveyor-General of Australia, giving results of an examination of a series of Fossil Remains from caves in 'Wellington Valley,' and published in his 'Three Expeditions into the Interior of Eastern Australia,' vol. ii. 8vo, 1838, one of the specimens was described as follows:—

"Genus Diprotodon.   I apply this name to the genus of *Mammalia*, represented by the anterior extremity of the right ramus, lower jaw, with a single large procumbent incisor (IX.), fig. 1, pl. 31.   This is the specimen conjectured to have belonged to the Dugong, but the incisor resembles the corresponding tooth of the Wombat in its enamelled structure and position (see fig. 2, pl. 31, and a section of the Wombat's teeth in fig. 7, pl. 30).   It differs, however, in the quadrilateral figure of its transverse section, in which it corresponds with the inferior incisors of the *Hippopotamus*.   To this *Diprotodon*, or to some distinct species of equal size, have belonged the fragments of bones of extremities marked X, X *a*, X *b*" (p. 362).

I reproduce the original figures (Woodcut, figs. 1 & 1 *a*) representing the specimen of half the natural size, and the section of the incisor of the full size, on which the genus was founded; but which specimen I now know to be that of a young individual.

Extraordinary as seemed the magnitude of the beast which this tooth indicated, at a period when the largest known mammal of Australia was a Kangaroo, it gave only half the size of the full-grown *Diprotodon australis*.

In ignorance of this fact I was led astray by the first evidences (femur and molar teeth)

Fig. 1.

of the mature animal which were transmitted to me from freshwater deposits in another and remote locality of Australia; and, for a short time, I believed them to belong to a Proboscidian, referring them, in 1843, on the authority of a drawing of part of a jaw and teeth transmitted to me by Sir Thomas Mitchell, to the Dinotherian section of that order[*].
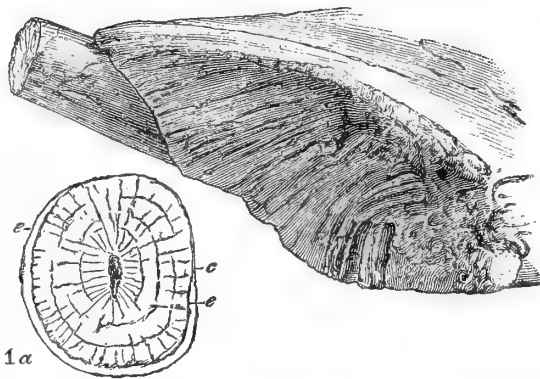
* Annals and Magazine of Natural History, No. 71, for May 1843.

But I was not long under this delusion, and in 1844 realized grounds for the following rectification:—" Having since received specimens of portions of lower jaws with teeth identical in structure with the fragment figured in my first communication to the ' Annals of Natural History ' (p. 9, figs. 2 & 3), I find that the reference of that portion of tooth to the genus *Dinotherium* was premature and erroneous.   The extinct species to which it belonged does indeed combine molar teeth like those of *Dinotherium* with two large incisive tusks in the lower jaw ; but those tusks incline upwards instead of downwards, and are identical in form and structure with the tusk from one of the bone-caves of Wellington Valley, described by me in Sir THOMAS MITCHELL's ' Three Expeditions into the Interior of Australia,' vol. ii. 1838, p. 362, pl. 31, figs. 1 & 2, as indicative of a new genus and species of gigantic mammalian animal, to which I gave the name of *Diprotodon australis*"*.

Of no extinct animal of which a passing glimpse, as it were, had thus been caught, did I ever feel more eager to acquire fuller knowledge than of this huge Marsupial. No chase can equal the excitement of that in which, bit by bit, and year after year, one captures the elements for reconstructing the entire creature of which a single tooth or fragment of bone may have initiated the quest ; in the course of which one finally realizes, with more or less exactitude, the picture which the laws of correlation had led one to frame of an animal which may have passed out of existence long ages ago†.

Appeals to friendly correspondents in Australia had met, in 1845, with so much success as enabled me to give the entire dental formula of the lower jaw, viz. *i*, 1, *c*, 0, *m*, 5; =6: and also to indicate a second genus of large herbivorous Marsupial (*Nototherium*) only inferior in size to *Diprotodon*‡.

Further evidences fell in at longer intervals, and I was occasionally flattered with the hope of obtaining an entire skeleton, as by the subjoined extract from my old ally in researches of Australian Zoology, Dr. GEORGE BENNETT, F.L.S., of Sydney, New South Wales.

Copy of part of a letter from GEORGE BENNETT, *Esq., F.L.S., dated Sydney,*
September 18th, 1863, *referring to a skeleton of* Diprotodon.

" . . . . I have some expectation of getting you more of the bones of the *Diprotodon* ; my son George, who is now on a station in Queensland, writes me as follows :—' I have been along the bank of a creek called ' King's Creek,' and searched it very minutely : I have found several bones, and also the place where the whole of a skeleton is imbedded in the ground.   The bones are immense, some of the vertebræ are about 12 or 14 inches in length.   I have now one of the smaller vertebræ, and it measures 6 inches in diameter.

* Annals and Magazine of Natural History for October 1844.

† I hazarded the expression, in 1843, of such an ideal picture, as " of a heavy terrestrial quadruped, like the Mastodon, with thick and stout extremities adapted to the support and progression of a massive frame."—Annals and Magazine of Natural History, vol. ix. p. 332.

‡ " Report on the Extinct Mammals of Australia, and on the Geographical Distribution of Pliocene and Post-pliocene Mammals in general," Reports of the British Association, 8vo, 1845.

The head of the same skeleton was sent some years ago to Sydney.   The shepherd who discovered the head is here still, and it was he who showed me the place.   When I can get time and men in that direction I will dig it out and then forward it by degrees to you.'

" Since I received this account," proceeds Dr. BENNETT, " I have seen Mr. W. B. TOOTH, the owner of the station, and he informed me that he has a large blade-bone, and that when he visits the station and has the men at leisure, he will gradually dig out the skeleton as perfect as possible and forward it to me.   Mr. T. left on the 15th of this month for the station.   I suggested to him to preserve every bone however small, which he has promised to do.   On my receiving only a few at a time I will immediately transmit them to you, as I expect it will take some time to excavate the whole skeleton, as men cannot be spared at all times from a large sheep station."

I have long (perhaps too long) deferred entering upon the work of the present com munication, hoping to complete the materials for the entire reconstruction of the *Diprotodon*.   But the quick lapse of time, its inevitable effect on mind and body, and the venial impatience of the possessors of nondescript bones of the great Marsupial, combine to put an end to delay, and I proceed, therefore, to the description of the parts of this extinct animal at present at my command.

§ 2. *Skull.*—It is probable that the specimen in the British Museum (Plate XXXV. figs. 1, 2, 3), purchased at the sale of a series of Australian Fossils sent to London from Sydney by a Mr. BOYD, and stated to have been obtained from the bed of a creek at Gowrie, near Drayton, Darling Downs, Queensland*, may be the " head " referred to in the letter above cited.

The chief dimensions of this skull are given in the 'Table of Admeasurements' of parts of the skeleton of *Diprotodon*, p. 573.

The skull shows the general marsupial character of that part in its degree of depression.or flattening from above downward, in the small proportion devoted to receive the brain, and in the large proportion given to the olfactory chamber and precranial air-sinuses.

The occipital region (Plate XXXV. fig. 1, ₃, fig. 3), instead of being vertical, as in *Macropus* (ib. fig. 5) and most existing Marsupials, slopes forward from the terminal condyles at an angle of 45° with the basicranial axis.

The basioccipital (ib. fig. 3, ₁) forms by a thick border convex vertically, slightly concave transversely, the lower part of the rim of the foramen magnum (ib. *o*) an inch in extent, separating in the same degree the lower ends of the occipital condyles (ib. 2, ₂). These ends may be contributed by the basioccipital element, but the sutures between it and the exoccipitals are obliterated.

* " All the above fossil remains are from King's Creek, Darling Downs, being the same locality whence the entire skull of the *Diprotodon* was obtained some years ago."—W. S. MACLEAY, in ' Report on Donations to the Australian Museum during August, 1857.'   See also " OWEN, On *Nototherium*," in Proceedings of the Geological Society of London, March 1858, p. 158.

The basioccipital, as it advances, expands and gains a thickness of nearly an inch of compact and minutely cellular bony tissue.

The occipital condyles (Plate XXXV. fig. 3, 2), an inch apart below and $2\frac{1}{2}$ inches apart above, have their lower extremity obtuse, about an inch broad, curved inward and forward; they expand as they ascend, diverging to a breadth of 2 inches at their upper ends. The vertical convexity of each condyle describes a semicircle, the extent of the articular surface following this curve being 6 inches. The outer border is longer than the inner one, so that the upper margin of the condyle rises obliquely from within outward. The narrow lower ends of the condyles rise or project more abruptly from the intervening basioccipital border of the foramen magnum than in *Macropus*. Each condyle is here impressed by a rough surface or shallow notch at its inner surface, indicative of tendinal insertion. A low narrow ridge extends from the outer part of the lower end of the condyle, forward, and may indicate the lateral extent of the basioccipital at this part. The transverse convexity of the condyle is greater, less angular, especially at the lower half, than in *Macropus*. The oblique base or upper end of the condyle projects proportionally more from the non-articular part of the exoccipital. A similar better definition or greater prominence characterizes the outer margin of the condyle; the inner margin forming the sides of the foramen magnum is sharper and better defined than in *Macropus*: these borders are also less divergent as they rise. The inner, non-articular side of the condyle is slightly concave, rough, subtuberculate. The outer border of the articular part is sharp, and projects over the inner non-articular side of the condyle. In their posterior terminal position and degree of prominence the occipital condyles of *Diprotodon* resemble those in *Dinotherium*.

The foramen magnum (ib. fig. 3, *o*) is bounded above by the arched obtuse border of the exoccipitals, which bones rapidly gain thickness as they extend from the foramen. I assume that the exoccipitals met above the foramen, as in many Marsupials; or, if not meeting, had their interspace filled by the superoccipital, as in *Phascolarctos*: they left here no notch, such as one sees in *Macropus Bennettii*. The upper border of the foramen magnum is non-emarginate in *Macropus major*; but it is relatively of greater extent in that Kangaroo, through the greater divergence of the condyles, and it is less arched or concave transversely than in *Diprotodon*. Two precondyloid foramina open upon each exoccipital, opposite the junction of the lower and middle thirds of the condyle, from which the hindmost foramen is distant 9 lines, the next 1 inch 2 lines; each foramen is about 4 lines in diameter. An irregular or tubercular ridge curves over the fossa of the precondyloid foramina, expanding to be lost on the paroccipital. This process (ib. figs. 1 & 3, *4*) is tuberous, thick, and short; it is not so much produced as in *Macropus*.

The foramen magnum is more *evasé* than in *Macropus*, i. e. it expands funnel-wise to its outlet, backward, and especially above and below; it has more the character of a short (neural) canal than a foramen, through the antero-posterior extent of its wall or rim. It is transversely elliptical, 2 inches 5 lines in long, 1 inch 3 lines in short, dia-

meters.   It opens directly backward, the plane of its outlet being vertical.   On each side of the inlet of the foramen magnum a wide and deep impression of a sinus curves downward to the jugular foramen at the inner side of the base of the paroccipital.   The inner openings of the precondyloid canal are in a slight depression on each side the foramen magnum, a little nearer together than the outlets.

In the almost entire skull the upper border of the foramen magnum and contiguous part of the superoccipital surface are wanting.   In the part of the occipital of another skull that surface is preserved to an extent of $2\frac{1}{2}$ inches in advance of the upper border of the foramen, and for a breadth of 6 inches.   This surface slopes forward from the foramen and condyles as in the entire skull; it is externally smooth and transversely undulating, showing a shallow medial concavity between two broad gentle convexities, which fall outwardly into concavities bounded by the oblique bases of the condyles.   Nearly the lower half of the superoccipital surface is preserved in the fragment: the upper half, present in the skull, shows a strong medial vertical ridge (Plate XXXV. fig. 3, 3), and is bounded above by the ridge between the superocciptal (3) and parietals (7), continued outwardly upon the mastoids (8).   The cranial air-sinuses are continued backward into the super- and ex-occipitals, not into the basioccipital.   On each side the mid-ridge (3) is a shorter vertical ridge.   The mastoid (8) makes a much less projection than the paroccipital (4); it is confluent above with the petrosal, as in other Marsupials; not preserving its primitive distinction from that sense-capsule as in the Babyroussa*.

The brain being small in Marsupials, and the disproportionate smallness of its case to the rest of the skull increasing, as in other natural groups of mammals, with the general bulk of the species in such group, this character is a striking one in the skull of *Diprotodon*.   Like its carnivorous contemporary the *Thylacoleo* †, the brain-case makes no convexity or out-swelling into the temporal fossæ; the inner as well as the outer and hind walls of these long and large lateral vacuities are concave, and form parts of a general though not uniform excavation.

The broad and low triangular superoccipital surface, strongly sloping forward as it rises from the condyles, contracts above to its apex, and is continuous there with a (sagittal) ridge of the coalesced parietals (ib. fig. 1, 7) extending forward to the interorbital region.   There the upper surface of the cranium begins to expand, and to swell into a pair of low convexities (ib. fig. 1, 11) which roof over the frontal sinuses.   The outer wall of this pneumatic part of the cranium has been crushed down by posthumous pressure or injury in the entire skull.

The nasals (Plate XXXV. figs. 1, 2, 15), in continuing forward from the frontals the upper line of the skull, rise gently toward their terminations, which again curve downward, giving a sigmoid contour to that part of the cranial profile in a degree peculiar to the present species.   The vertical diameter of the facial part of the skull at the ter-

* Owen, 'Anatomy of Vertebrates,' 8vo, vol. ii. p. 469 ; and 'Catalogue of the Osteology, in the Museum of the Royal College of Surgeons,' 4to, no. 3345, p. 557.

† Philosophical Transactions, 1866, Plate I.

mination of the nasals rather exceeds that of the cranial part at the parietal region; it is also greater than the beginning of the facial part of the skull in advance of the orbits and molar alveoli, whence there is a gain both in depth and breadth as it approaches the anterior terminations; but the uniformity of this diameter of the skull along the medial line, from the superoccipital forward to the premaxillo-nasal part, viewed sideways or in direct profile, is a remarkable characteristic of *Diprotodon*.

The part of the maxillary (Plate XXXV. fig. 1, ₂₁) lodging the molar series of teeth (*d* 3–*m* 3) breaks the lower line of the profile, descending below it along the middle third of the length of the skull. The zygomatic arch is deep, long, but proportionally less convex outwardly, or less expanded, than in *Thylacoleo*. Its base (ib. figs. 1 & 3, ₂₇) seems as if continued from the whole side of the occipital plane, contracting rapidly at the upper border as the arch sweeps outward and forward; the superoccipital crest being continued into the upper border of the arch, and this apparently without break or abrupt rise in any part of that border[*]. The frame of the orifice of the "meatus auditorius" (ib. fig. 1, ₂₈) projects downward from the hind part of the lower border of the base of the zygoma, indicative of the tympanic. Immediately in front of this descends the postglenoid process (*a*) of the squamosal, and in advance of this is a second downward projection or convexity due to the "eminentia articularis" (*b*), which is here, as in Marsupials, a process of the malar (₂₆). From this part the lower border of the zygoma runs forward nearly parallel to the upper one, but with a slight concavity, as far as the maxillary element of the zygoma, which sends down a strong, moderately long, obtuse, subcompressed masseteric process (ib. ₂₁′)—a cranial feature which is peculiar to herbivorous Marsupials[†].

The orbit (ib. fig. 1, *r*) is a relatively small vertically oval cavity, communicating widely behind with the temporal fossa (ib. ₇). The external nostril (ib. figs. 1 & 2, *n*) is terminal, subvertical, rather expanded, and divided in great part by an upward extension of the medial nasal plate of each premaxillary (ib. figs. 1 & 2,₂₂′), which plates, being in close contact, form the lower part of a long "septum narium" at the outlet of the nasal cavity, recalling its condition in the extinct *Rhinoceros tichorhinus*. There is a narrow and short descending ridge at the coadapted medial borders of the nasals, which seems to have been continued into the septum by cartilage rather than by bone. I have alluded to the analogy which the structure of the external nostrils in *Diprotodon* suggest to those of an extinct Pachyderm, but the truer and closer resemblance is found in the Marsupial group. The cavity of the nose is divided by a complete bony septum to within one-fourth of the outer opening in *Macropus* and *Phascolomys*[‡], advancing, in one species of Wombat, as in *Nototherium*, nearer to that outlet.

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[*] Some mutilation of the hind part of this upper border in both zygomata begets reserve in definitely pronouncing as to its normal outline.

[†] The descending masseteric process in Glyptodonts, Sloths, and Megatherioids is formed by the malar bone exclusively. OWEN, 'Anatomy of Vertebrates,' vol. ii. p. 405, figs. 273, 274, 26, *a*.

[‡] "On the Osteology of the Marsupialia," Zoological Transactions, vol. ii. p. 391. Anatomy of Vertebrates, vol. ii. p. 348.

The base of the masseteric process of the maxillary (Plate XXXV. fig. 1, 21′) is a vertical outstanding ridge, beginning below about an inch above the fore part of the last molar alveolus, or above the interspace between the last and penultimate sockets, according to the age of the individual.   It becomes thinned as it rises and projects, and then suddenly expands to form the fore part of the zygoma and to send down the process.   This is slightly twisted upon itself outward and backward, concave on the hinder and inner surface, convex at the opposite surface; the fore part of the vertical base of the zygomatic process of the maxillary is smooth and concave.

The alveolar border of the maxillary contracts and terminates obtusely behind the last molar (m 3, Plate XXXVIII. fig. 2).   It articulates with the palatine, leaving a hinder angular interval into which the lower and fore part of the pterygoid is wedged.   The outer part of the concave hind border of the bony palate curves from the pterygoid inward and forward to opposite the mid-division of the last molar: the palatines appear to complete, with the maxillaries, the hind part of the roof of the mouth, without leaving a vacuity.

Portions of the maxillary and palatine of two other individuals are equally without indications of any wide postpalatal vacuity opposite the interspace between the last and penultimate molars.   In advance of this interval the bony palate, due here to the maxillaries exclusively, extends so as to give a breadth of the palate between the penultimate molars of $4\frac{1}{2}$ inches.

Anterior to the masseteric process the outer alveolar wall of the maxillary is undulated by the vertical prominences, indicative of the large and thick roots of the molar teeth. The alveolar border contracts as the teeth advance in position and decrease in size, and becomes a ridge anterior to the first molar in place (usually the second of the series (d 4) in full-sized *Diprotodons*).   This antalveolar or diastemal ridge (Plate XXXV. fig. 1, x) curves upward and inward, approaching its fellow, then arches downward and terminates at the back part of the socket of the third incisor, where the maxillo-premaxillary suture begins.   At the wider hind part of the interval, between the antalveolar ridges, there seems to have opened an anterior or prepalatal canal leading to the fore part of the nasal cavity, the orifice being elongate.   In advance of this the deep and narrow channel between the fore part of the diastemata is entire.   Above these ridges, the outer plates of the maxillaries swell outward as they ascend to form the lateral walls of the antorbital part of the nasal chamber, arching inward again above to join the nasal bones (15).

The maxillo-nasal suture seems to have a relatively greater extent than in *Phascolomys*; but owing to the short facial or antorbital part of the skull, as compared with *Macropus*, it is of much less relative extent than in that genus.   The antorbital foramen (ib. figs. 1 & 2, 21) is longest vertically.

Each premaxillary (Plate XXXV. figs. 1 & 2, 22) is deeply excavated by three alveoli, the foremost the longest, largest, and most curved.   The inner walls of these alveoli rise as a strong vertical crest (22′) dividing the lower part of the nasal outlet.   The incisive alveoli succeed each other from before backward; and, owing to its superior size,

the outer border of the first projects further from the midline than does that of the last. Viewed from the palatal aspect the two series of incisive alveoli converge backward, instead of forward as in the Kangaroo and most other quadrupeds. The malar bone (Plate XXXV. fig. 1, 26) ascends from its junction with the maxillary to join the lacrymal (73) at the fore part of the orbit, by a very narrow curved strip or process; its main body is suspended in the zygomatic arch, of which it constitutes the anterior half, and the lower part, as far as, and including, the "eminentia articularis." The suture between the squamosal and malar elements of the zygoma is almost straight, extending from behind the orbit obliquely backward and downward to the glenoid cavity, of which articular surface the malar "eminentia," here more flattened than usual, contributes the fore part. This articulation (ib. fig. 4) is most extended transversely to the skull's axis; its hinder half (ib. ib. 27) is concave from before backward, its fore part (ib. ib. 26) convex, but becomes flattened or a little hollowed on the "eminentia."

The lacrymal (ib. fig. 1, 73) is perforated by the canal, marsupial-wise, in advance of and external to the orbital cavity.

§ 3. *Mandible.*—A transversely extended subconvex condyle (Plate XLII. figs. 3 & 4) adapts itself to the cavity offered by the base of the zygoma. The condyle is $5\frac{1}{2}$ inches in transverse extent, 1 inch 9 lines from before backward; it is, in that direction, most convex. The condyloid process is supported by a three-sided neck quickly contracting to 1 inch 9 lines in transverse diameter (ib. fig. 3, n); it is broadest and flattened behind, contracted in front to the ridge-like beginning of the "coronoid" plate (ib. figs. 2 & 4, r), which extends forward near the outer side of the neck. The condyle is more extended inward (ib. fig. 4, c) than outward (ib. ib. c') of this advancing vertical coronoid plate. The flat surface at the back part of the neck is continued into a suddenly expanded hinder facet of the ascending ramus, formed by the outward production of the hind wall or boundary of the outer depression for the insertion of the temporal muscle, and by the inward production (Plate XXXV. fig. 3, e) of the hind wall or boundary of the deep inner concavity of the ascending ramus, where opens the large entry (Plate XLII. fig. 2, o) of the dental canal. Below this orifice the concavity extends downward through the concomitant extension of the inner plate or hind wall to the lower border of the horizontal ramus, where it gradually subsides. The hind wall of the outer depression of the ascending ramus (Plate XXXV. fig. 1, e) follows the contour of that of the inner depression, but sooner subsides; the interspace is a continuation of the broad hind flattened facet which, as it descends, gets a more outward aspect. Beyond the subsidence of the outer plate it gives the appearance of a bending inward of the angle of the jaw (ib. fig. 2, e'), and that to a degree which is characteristic of Marsupials. The outer or crotaphyte depression of the ascending ramus (Plate XXXV. fig. 1, f) gradually gains the ordinary level of the outer surface of the horizontal ramus, and does not undermine the ascending branch to communicate with the inner concavity as in *Macropus*. In the shape of the condyle *Diprotodon* resembles *Phascolomys*, in which the intercommunicating canal is much reduced.

The anterior border of the ascending ramus is straight and subvertical; it is thickened at its lower part to be continued into the convex outswelling of the horizontal ramus outside the last molar (Plate XXXV. fig. 1, *m* 3), a distance of an inch intervening between the alveolus of this molar and the convexity rising and thinning into the fore part of the coronoid plate (*f*). The alveolar border is continued into an obtuse ridge or prominence, 2 inches behind the last alveolus; from which prominence the ridge subsides and expands, retrograding to form the internal border of the entry of the dental canal (ib. *d*).

The horizontal ramus gains slightly in depth as it advances from the last to the first molar socket (*d* 3). Two and a half inches below this socket, and a little in advance, is the vertically elliptic outlet of the dental canal (ib. ₃₂). Below this orifice the ramus bulges out into a rather rough tumefaction, then slopes and contracts upward and forward to form the socket of the huge procumbent lower incisor (*i*). From the socket of *d* 3 the alveolar border sinks and expands into the upper part of the socket of the incisor. The under border of the horizontal ramus is smoothly and broadly convex transversely. The inner surface sinks sheer from the openings of the molar alveoli, and curves inward below the anterior ones to the symphysis (Plate XLI. fig. 2, *s, s*). The fore part of the mandible below the incisive alveoli, expanding to the tuberous outswellings above-mentioned, has a broad, subquadrate form, recalling the shape of that part in the *Hippopotamus* (Plate XXXV. fig. 2, *t, t*).

The symphysis (Plates XLI., XLII. fig. 2, *s, s*) begins behind, at a line dropped vertically from the front lobe of the third molar (*m* 1); it is 6 inches in length, 4 inches in depth in the full-grown animal. It gains in vertical direction more than in length during the growth of the mandible, with reference apparently to the provision of a sufficient lodgment of the progressively increasing incisive tusk. (Compare Plate XLI. fig. 2, *s, s* with Plate XLII. fig. 2, *s, s*.)

The large size of the dental canal exposed by the posterior fracture of the ramus of another mutilated mandible indicates the ample supply of vessels and nerves which minister to the growth and nutrition of the incisive tusk; the depth of the symphysis of the jaw corresponds with the tusks, which it helps to support; contributing to the required strength for the operations of those eroding implements, with space for the deep implantation and for the lodgment of the large persistent matrix of each tusk (Plate XLII. fig. 5). The direction of the symphysis is oblique, from below upward and forward; its upper margin is nearly straight, its lower one convex; the rough articular surface stands out a very little way from the vertical plane of the inner surface of the ramus.

In comparing the symphysial part of the jaw of *Diprotodon* with that of any other large quadruped carrying a single incisor in each ramus there are well-marked differences. The symphysis in the Sumatran *Rhinoceros* and in *Acerotherium* is less deep and is proportionately broader; the great length of that part in the *Mastodon longirostris*, and its deflection in *Dinotherium* more conspicuously differentiate them. In the remark-

ably large proportion of the symphysis in *Diprotodon* to the size of its molar teeth there are no quadrupeds which so nearly resemble it as the Notothere and the Wombat; but in this existing Marsupial the symphysial part of the jaw is broader in proportion to its depth. The long and narrow symphysial junction in the Kangaroo is peculiar for the yielding movements allowed to the rami upon each other, which is betrayed by those of the long procumbent depressed incisors in the living animal[*].

§ 4. *Dentition.*—The dental formula of *Diprotodon* is:—$i\frac{3-3}{1-1}$, $c\frac{0-0}{0-0}$, $m\frac{5-5}{5-5}=28$. Of the upper incisors the first or anterior pair (Plate XXXV. figs. 1 & 2, *i* 1; Plate XXXVI. figs. 1–6) are large curved scalpriform teeth, of which I have not found indications of cessation of growth in any specimen. The skull above described and figured (Plate XXXV.) has been that of an aged male, judging from the size and degree of attrition of the teeth which are retained; but the anterior incisors above, like the pair below, are continued to the bottom of their deep alveoli without contraction, and with the retention of a widely open pulp-cavity (Plate XXXVI. fig. 6). It is obvious that these strong anterior incisors (ib. figs. 1–4) worked with the evergrowing power of the " dentes scalprarii" of the Wombat, the Aye-aye, and the Rodents.

In the above skull the length of *i* 1, following the convex curve of the tooth, is 11 inches; its circumference is 4 inches 9 lines; the breadth of the oblique abraded working surface is 1 inch 9 lines; the longitudinal extent of that surface is 2 inches; but this varies in other specimens. An extent of the tooth of $8\frac{1}{2}$ inches (following the outer curve) is lodged in the socket of the premaxillary.

I made a transverse section of a fragment of the skull of a *Diprotodon*, including the fore part of the premaxillaries and their scalpriform teeth (Plate XXXVI. fig. 5). Such section of the tooth (*i* 1, *c, d, e*) is irregularly three-sided, with the angles broadly rounded off. The inner side, or that next the fellow tooth, is the narrowest; the front or enamelled side is the broadest: this side is traversed lengthwise by a wide and shallow mid channel; the opposite side is grooved by a narrower and rather deeper channel, running along its outer half; and the inner more prominent half of this side (the concave one lengthwise) also shows a narrow and feeble impression near the mid-line of the tooth, and a broader more shallow impression nearer the angle, dividing the hinder from the inner surface. This surface, 1 inch 3 lines across (ib. fig. 2), is generally somewhat convex, but wavy through two or three low obtuse longitudinal ridges, with intervening shallow channels. A fossil fragment of a similarly sized tooth yielding such transverse section as that shown by this remarkable scalpriform incisor would, according to present experience, determine the genus of Mammal to which it had belonged.

The enamel coating the anterior convex curve of the tooth is continued over the major part of the outer rounded surface, terminating abruptly along a line (ib. fig. 5, *e*) external to the outer longitudinal ridge (*c*) of the posterior surface. In like manner the enamel is continued over the rounded angle between the anterior and inner or medial sides of the incisor, and terminates abruptly at *e*, fig. 5, after covering about one-

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[*] First noticed by MASON GOOD, 'Book of Nature,' vol. i. p. 283.

third of the inner surface. The hinder and two-thirds of the inner sides of $i\,1$ are thus uncoated by enamel, the dentine (d) showing there only a thin coating of cement (c).

The surface of the enamel is longitudinally striate and punctate (Plate XXXVI. figs. 3 & 4); the fine pits being chiefly but not wholly between the striæ; so that in some parts the surface seems to be minutely reticulate or reticulo-punctate. The surface of the dentine to which the enamel was applied shows a similar but less marked character. The cement (c) is thickest where it overlaps the terminal edges of the enamel.

The second upper incisor (Plate XXXV. fig. 1, $i\,2$; Plate XXXIX. fig. 7) is slightly curved, but in an opposite direction to the first, the anterior longitudinal outline being concave: the degree of this bend seems greater through the oblique attrition of the tooth from behind downward and forward. The transverse section of this incisor is subcircular. The length of the exposed part of the tooth is 3 inches; the circumference is 3 inches 6 lines; but this slightly diminishes to the margin of the socket, and more so to the inserted end. The fore-and-aft extent of the abraded working-surface of the tooth (ib. fig. 8) is 1 inch 6 lines. The length of the entire tooth does not exceed 4 inches.

The third upper incisor (Plate XXXV. fig. 1, $i\,3$), of similar form, is smaller. The length of the exposed part is 2 inches 10 lines; its circumference is the same; the fore-and-aft extent of the worn surface is 1 inch. This surface runs upon the same level as that of the second incisor. The crown of the large lower incisor, besides applying its trenchant edge against that of the broader front incisor, scraped upon both the smaller incisive teeth. Probably, by reason of the age of the individual and the extent of tooth worn away, the original enamelled crown has gone, and both $i\,2$ and $i\,3$ are here represented only by their cylindrical cement-covered portion.

A specimen of a detached second upper incisor is in the same condition: the enamelled crown is worn away, the root contracts to its implanted end, which shows a small remnant of a conical pulp-cavity 8 lines in depth and the same in width, as in fig. 7, Plate XXXIX.

The second and third incisors of *Diprotodon* were teeth of limited growth, and with the enamel confined to and thus defining a crown as in the Kangaroos; whilst the front incisor was a scalpriform tooth as in the Wombats, in which the second and third incisors are not developed. The extinct *Diprotodon* thus exemplifies an interesting intermediate or transitional condition of the upper " dentes primores" unknown in any existing form of *Marsupialia*.

In the upper jaw of the skull above described (Plate XXXV.) the molar series is in place, with the exception of the first small tooth ($d\,3$). The other four teeth occupy, on each side the jaw, a longitudinal alveolar extent of 7 inches 4 lines. The homologies of these teeth with those in *Macropus* are indicated by the symbols used in my 'Anatomy of Vertebrates,' vol. iii. fig. 296, where the grounds for such use are given, and in fig. 1, Plate XXXV. of the present Memoir. Scarcely a trace of the socket of the first small molar ($d\,3$) remains in the skull; the other molars progressively increase in size to the last ($m\,3$), which has a minor breadth of the hind lobe than in $m\,2$. The line of the

working surfaces of the four molars describes a slight convexity downwards (Plate XXXVIII. fig. 1); the exterior line is also slightly convex (ib. fig. 2); the interior line is concave in a less degree; the right and left series are moderately convergent anteriorly. The interspace between the hind lobes of the last molars (m 3) is 4 inches 1 line; that between the front lobes of the first molars (d 4) is 3 inches 1 line; these dimensions give the breadth of the palate between the right and left teeth above symbolized.

All the molars in place have an enamelled crown divided into two transverse lobes (Plates XXXVII., XXXVIII. a, b), with accessory ridges (f, g), and are inserted by cement-clad contracting roots as in *Macropus*. The summits of the transverse lobes are abraded in all the molars of the specimens figured; but least so in the hind lobe of the subject of m 3, fig. 2, Plate XXXVIII.

The socket of the first small molar (fig. 1, d 3) is partially preserved in the entire skull; it consists of two cavities, the hindmost the largest, the tooth having only two roots. In the subject of Plate XXXVII. figs. 1 & 2, the crown of d 4 is ground down nearly to the bottom of the cleft (h); the fore-and-aft extent of the grinding-surface is 1 inch 2 lines; its transverse extent across the hind lobe is the same. Across the fore part of the base of the tooth is a low ridge (f), to the level of which the anterior lobe (a) is almost worn. The corresponding ridge at the back part of the tooth is continued along both the outer and inner borders (g, g) of so much of the back part of the hind lobe as is not ground down; the whole of the surface projects beyond the level of the worn surface of the following molar (fig. 1, m). The transverse cleft is deepest at its outer and inner ends; a ridge of enamel descends from each of these ends of the anterior lobe, and, meeting a corresponding projection of the oppposite lobe, it partially closes the entry of the valley.

The anterior basal ridge is strongly developed in m 1, especially at its inner end; the interspace between it and the anterior lobe widens toward the inner side of the tooth (f). The anterior lobe is worn down nearly to the level of the ridge; the surface describes a transverse irregular ellipse; that of the posterior lobe is narrower: in both a mid linear tract of osteo-dentine (o, o) is exposed. The narrow hind basal ridge (g) is continued upon the hind lobe as in p 4, and that lobe projects clear beyond the level of the grinding-surface of m 2. The antero-posterior and transverse diameters of the working-surface of m 1 are each 1 inch 6 lines.

The anterior basal ridge (f) is strongly developed in m 2, and the antero-posterior diameter of the tooth (1 inch 9 lines) rather exceeds the transverse diameter. The front lobe (a) is worn down to within 5 lines of the basal ridge. The minor degree of abrasion of the hind lobe shows the curve of the grinding-surface, concave backward, which is lost as the thicker part of the lobe is reached. The hind basal ridge (g) is feebly developed.

In the last molar (m 3) the hind lobe is markedly less than the front one, by its more rapid loss of transverse dimension: it is rather narrower in this line at its base, as it is in fore-and-aft extent. The last upper molar of *Diprotodon* may be readily determined by its posterior contraction. In some individuals the hind surface of the hind lobe

is less evenly concave transversely; I have seen it almost canaliculate. The loss of breadth of this lobe is chiefly from the outer side, and the lobe is lower than the front one, the level of the grinding-surface reaching halfway toward that of the front lobe. The fore-and-aft extent of the base of the tooth is 2 inches; the transverse extent of the worn surface of the front lobe is 1 inch 6 lines; that of the hind lobe is 1 inch 3 lines. The anterior ridge (fig. 4, f) is continuous with a feeble rising of the enamel at the outer and the inner borders of the front surface of the anterior lobe. The posterior basal ridge (Plate XXXVIII. fig. 3, g) is more directly and conspicuously continued into the ridge along the inner border of the posterior surface of m 3.

Wherever sufficient of the lobes remains, their profile, especially the outer one, describes a curve concave forward (Plates XXXVII., XXXVIII. fig. 1). The inner and anterior angle of each tooth, due to the more prominent part of the front basal ridge, projects inward, a few lines beyond the inner surface of the tooth in advance (ib. ib. fig. 2). Thus there is not only a zigzag disposition in the vertical but in the transverse arrangement of the upper molars, though in the latter it be but slightly marked. The enamel is about a line in thickness, and shows strongly the reticulo-punctate or rugous surface at the less exposed parts of the crown.

The upper molars are implanted by fangs which acquire twice the length of the enamelled crown: they are at least three in number, save in the first small and early deciduous tooth (d 3). The base of the anterior division of the tooth bifurcates as it descends, slightly contracting in the socket, and thus forming two fangs in the same transverse line. The base of the posterior division, if it bifurcates in any molar, is divided later and to a less extent. It gradually contracts, and is longitudinally excavated at the side next the other fangs.

Figure 5, in Plate XXXVIII., gives a view of the two anterior fangs (m, n) of the last molar; fig. 6, ib., shows the single posterior fang (l) of the same tooth. Plate XXXIX. fig. 3 shows the sockets and implanted ends of the fangs of the antepenultimate and last molar teeth. The outstanding antero-posteriorly compressed zygomatic process of the maxillary (n') is here opposite the hind lobe of m 2.

In the series of upper molars of *Diprotodon* there are varieties as to size, and as to order or degree of wear, the former variety being more constant. Both are exemplified in the specimens figured in Plate XXXVII. figs. 2 & 3. In fig. 3, a portion of the left upper jaw with the last three grinders, m 1 shows both lobes and the anterior ridge worn down to a common field of dentine (d) and osteo-dentine (o, o): the summits of m 3 are partially abraded. In fig. 2, in which the last molar (m 3) shows an equal degree of abrasion, the antepenultimate molar (m 1) is not worn to the same degree as in fig. 3; the anterior lobe is ground down near to the basal ridge (f), but this remains untouched; the valley between the two main lobes is not obliterated. What is still more unusual, where the last molar has come into use, the second molar (p 4, fig. 2, Plate XXXVII.) preserves its lobes hardly worn down to the bottom of the valley, and the two fangs of the first molar (d 3) remain in their alveolus.

A cursory comparison of the two foregoing specimens suggests that *m* 1 (fig. 3, Plate XXXVII.) may have been destined to be pushed out by a vertical successor, which, in place in the larger specimen (*m* 1, fig. 2, Plate XXXVIII.), shows of course a less degree of abrasion. But this is not the case. I have in vain sought for evidence of any premolar, in either upper or lower dental series of *Diprotodon*: it differs from *Macropus* and resembles *Phascolomys* in this particular. All the teeth, like the last three grinders in the type diphyodont dentition, belong to the first set. The variety as to degree of attrition in molars of the same series is due to some modified habit of mastication: the difference in respect of size I ascribe to sex, the smaller grinders belonging to the female, concomitantly with a general inferiority of bulk, as is seen in *Macropus*. The following admeasurements exemplify the difference of size in molar teeth, which is probably sexual:—

			Diprotodon.			
		Male.		Female.	
		in.	lines.	in.	lines.
m 3. Antero-posterior diameter		1	10	1	7
Transverse posterior diameter (base of front lobe)		1	11	1	6
m 4. Antero-posterior diameter		2	3	2	0
Transverse posterior diameter		2	0	1	7
m 5. Antero-posterior diameter		2	4	2	1
Transverse posterior diameter		2	0	1	$7\frac{1}{2}$
Antero-posterior extent of *m* 3, *m* 4, *m* 5		6	0	5	10

The forms and proportions in which the four constituents of the molar teeth of *Diprotodon* are combined, are exemplified, in the vertical longitudinal section of the last three upper grinders, in Plate XLII. fig. 1. The enamel (*e*) gains thickness as it recedes to a certain extent from the summits of the lobes, giving more resistance or grinding-power as the tooth wears down; but the enamel thins again at the base of the lobe; it gains a little more thickness as it is reflected, so to speak, over the basal ridges, beyond which it extends from three to four lines before thinning off, and ceases upon the body of the tooth before its division into fangs. The usual general direction of the dentinal tubules is well displayed, as in most fossil teeth. As the dentine becomes exposed and abraded, the pulp-cavity is defended by the coarser calcification of the remaining matrix near the field of abrasion, and from 2 to 3 lines of osteo-dentine is interposed between that field and the pulp-cavity. In each lobe of the tooth most worn (*m* 1) the cavity is reduced to a linear trace. In the anterior lobe of *m* 2 it is more expanded; and it retains width in both lobes of *m* 3. In each tooth the pulp-cavity has received a lining of dark-coloured spar in the course of fossilization. The cement is thickest upon the back part of the hind root (*c*), whence it extends upon the posterior basal ridge: this partial excess of cemental development assumes a characteristically definite figure in such sections as the one described.

The lower incisors (Plates XXXV., XLI. & XLII. *i*; Plate XXXIX. figs. 4, 5, 6) are

nearly straight; the very slight degree in which they deviate from that line tends to an upward curve (Plate XXXIX. fig. 4).

The length is 10 inches, the circumference 5 inches 6 lines. The longitudinal extent of the worn surface in those of the skull (Plate XXXV.) is 3 inches; its transverse breadth is 1 inch 4 lines. The transverse section of the entire tooth (Plate XXXIX. fig. 6) is oblong; in some it presents an irregular oval with the small end upward. The outer side at its lower two-thirds is usually prominent; the inner side is more even or flat, in some instances feebly convex; in one specimen very slightly concave along its middle third. The outer side is more constantly traversed by a narrower shallow longitudinal channel, rather above the middle of that side. The enamel (Plate XXXIX. figs. 5, 6, e) is continued from the border of this channel round the lower part of the incisor, to about one-fifth of the extent of the inner side (ib. e'): its terminal borders are abrupt on both sides, with the rather thick cemental covering of the unenamelled part of the circumference extending over the enamel borders. The surface of the enamel is finely ridged lengthwise and reticulo-granulate; the minute studs of enamel being, however, more conspicuous than the holes; although these are not absent.

About two-thirds of the tooth is lodged in the socket, which extends backward a little beyond the symphysis, but without causing, as in Rodents, a prominence of the inner wall of the ramus (Plate XLI. fig. 2); in this respect *Diprotodon* resembles *Macropus* and *Phascolomys*. The line of the socket forms an angle of 147° with the basal line of the mandibular ramus. The pulp-cavity (Plate XLII. fig. 5, p) is a long cone widely open at the base. The pair of tusks run almost parallel, slightly approximating so as to come into contact at their working ends.

The form of the lower incisor, described as it is shown in the most perfect specimen of the lower jaw of a full-grown example, is subject to some variety. Being a tooth of unlimited growth, it increases with the size of the jaw. In young specimens the out-swelling of the outer side, or the contraction of the upper third of that side, is either not apparent or not so conspicuous, and the transverse section of the incisor yields a full oval, as in that of the young *Diprotodon* from the Wellington Valley Cave * (Cut, fig. 1 a), and, slightly modified, in the one of similar age from Darling Downs, Queensland (Plate XLI. fig. 1, a).

But under all these slight varieties, which I cannot regard as specific, there prevail the same essential characters of structure, disposition of enamel, &c., pointed out in my original Memoir as differentiating *Diprotodon* from *Halichore*, *Hippopotamus*, and other Mammals with tusks of similar size.

A diastema, between three and four inches in extent, rises gently as it recedes from the incisor (Plate XLI. i), to the first molar (d 3), and more so, as the molar series becomes completed and pushed out for use as in Plate XXXV. fig. 1, and Plate XLII. fig. 2.

Of the first molar tooth (d 3) I have no specimen. Its existence was indicated by traces of its socket in the portion of mandible obtained by Dr. E. C. HOBSON, from a gravel-

* MITCHELL's 'Three Expeditions into the Interior of Australia,' 8vo, 1838, vol. ii. p. 362, pl. 31. figs. 1 & 2.

bed in the "Melbourne district," described in my 'Catalogue of Fossils in the Museum of the Royal College of Surgeons' (4to, 1845), p. 308, no. 1491; and such trace of socket showed the tooth to have been implanted by two fangs. The corresponding divisions of the socket of *d* 3, with the fangs *in situ*, are better preserved in the specimen figured in Plate XLII. fig. 5, and Plate XLIII. figs. 1 & 2, *d* 3. Dr. Hobson, shortly before his death in 1848, transmitted to me a sketch of this tooth *in situ*, in a fragment of the lower jaw of a young *Diprotodon* (Cut, fig. 2), according to which the anterior as well as the posterior lobe of *d* 3 is in the form of a transverse wedge; there is a basal ridge along both the fore and hind parts of the crown, the latter being the broadest; in short, *d* 3 presents, in miniature, the bilophodont type of the succeeding molars. From the attrition of the two lobes it may be inferred that the opposing molar above was also transversely two-ridged. That the tooth (fig. 2) answers to the one which occupied the socket (*d* 3) in Plates XLI. & XLII. fig. 5, is shown by correspondence of size. The fore-and-aft extent of the socket in both is 9 lines, the breadth of the division for the anterior fang is 4 lines, of that for the posterior fang $4\frac{1}{2}$ lines; the alveolar wall extending transversely between the two divisions exceeds a line in thickness; each fang is subcircular at its fractured end, with an indent at the side turned toward the other fang, indicative of a longitudinal groove into which the walls of the socket enters, giving a firmer implantation to the tooth.

Fig. 2.

First lower molar, *d* 3, young *Diprotodon*, nat. size.

In the portion of mandible (Plate XLI. & XLII. fig. 5) the penultimate molar (*m* 2) had not risen completely into place, and the posterior lobe was barely touched by masticatory work. In the mandibular ramus (Plate XLII. fig. 2), with the last molar (*m* 3) in place and both ridges showing wear, the two divisions of the socket of *d* 3 are retained, without trace of tooth. The fore-and-aft extent of the socket is 9 lines, that of the hind fossa or division is $3\frac{1}{2}$ lines, that of the front one $2\frac{1}{2}$ lines, and that of the intervening bar is $2\frac{1}{2}$ lines at its prominent part.

In the younger jaw the second molar (Plate XLI. figs. 1 & 2, *d* 4) has both lobes of the crown about half worn down; the fore-and-aft extent of the crown, including the anterior and posterior basal ridges, is 1 inch 6 lines. The anterior basal ridge is thickest at its outer part, and here the enamel has been worn off in mastication. The flat fore side of the front lobe rises 5 lines above the ridge. The abraded surface (Plate XL. fig. 3, *a*) of this lobe is 8 lines in transverse and 4 lines in antero-posterior extent, the mid part being increased in this direction by an outswelling of the hind surface there of the lobe. The outswelling of the front slope or surface of the hind lobe is situated more outwardly: the abraded surface (Plate XL. fig. 3, *b*) of this lobe is narrower from before

backward, broader transversely, than that of the front lobe. A low and short ridge of enamel (*h*) closes both outer and inner ends of the intervening transverse valley. The length or vertical extent of crown between the end of the valley and the division into fangs is 5 lines on the inner side and 4 lines on the outer side of the tooth. The middle of the hind surface of the hind lobe swells out; and as both outer and inner ends of the hind basal ridge (*g*) bend up the corresponding parts of the hind lobe, its hind surface shows two shallow depressions divided by the above-named rising: in these depressions the reticulo-punctate character of the enamel is most strongly marked. The hind basal ridge is thicker than the front one (*f*), and thickest at its middle; its enamelled margin is irregular, it rises higher than, and seems to overlap, the front basal ridge of the following tooth. The cement upon the exposed part of the crown of *d* 4, between its enamelled lobes and implanted fangs, is thick. The fangs are two in number, broadest transversely, slightly divergent, canaliculate on the contiguous sides.

In the jaw of an older *Diprotodon* the second molar (Plate XL. fig. 4, *d* 4) shows both lobes abraded to their common base, exposing the osteo-dentine (*o*) obliterating the cavity of the fang. A small part of the enamel of the front basal ridge (*f*) shows its position as blended with the front lobe. The line of enamel of the worn hind surface of the hind lobe (*b*) forms an open angle, of which the apex shows the end of the prominence joining the middle of the hind basal ridge (*g*), and dividing the remnants of the pair of depressions between that ridge and the hind lobe. The fore-and-aft extent of the worn surface of this molar is 1 inch 6½ lines; that of the base of the crown is 1 inch 8 lines; the breadth of the hind part of the worn surface is 1 inch. The alveolar border rises into an angle between the origins of the fangs.

In Plate XL. fig. 2 shows the working-surface of the crown of *d* 4, of rather smaller size than those above described, and probably from a young female *Diprotodon*. The summit of the anterior lobe is so far worn as to expose a transverse curved line of dentine, concave forward, beginning to expand where attrition has reached the prominent part of the hind surface of the lobe. The summit of the posterior lobe (*b*) has just been touched. The proportions of the basal ridges (*f*, *g*) are well shown. The reticulo-punctate character of the enamel is well marked. This tooth was from the freshwater deposits of the Province of Victoria, near Melbourne. The outer side view of this tooth is given in figure 1.

From the same locality I received the third molar (*m* 1) of the same *Diprotodon* (Plate XL. figs. 5 & 6): its almost untouched lobes are more compressed than in the Tapir and Dinothere, and their lamelliform summits rise higher beyond their basal connexions than in the Kangaroo; the median connecting ridge which extends between the two transverse eminences longitudinally, or in the axis of the jaw in the molars of the Kangaroo (ib. fig. 14), is very feebly indicated by the outswelling, shown in figs. 3 & 7, at the back of lobe *a*, in the *Diprotodon*. The anteriorly concave curve of the summits of the transverse lobes, in fig. 6, is more regular, equable, and greater than in the Tapir (fig. 15), the Dinothere, or the Kangaroo. The two fangs, the contiguous

surfaces of which present the deep and wide longitudinal groove, as in the Tapir, Dino-there, and Kangaroo, are connected together at their base by a ridge coated thickly with cement, and extending longitudinally between the beginnings of the opposite grooves in *Diprotodon.*

The third molar in the young specimen (Plate XLI. figs. 1 & 2, *m* 1) has both lobes par-tially abraded; the fore-and-aft extent of the tooth is 1 inch 10 lines, the basal breadth of both lobes is the same, viz. 1 inch $1\frac{1}{2}$ line. The reticulo-punctate or "worm-eaten" character is strongly marked on the enamel of the fore part of the front lobe; this is slightly concave transversely at its upper part, the outer and inner borders inclining forward to receive the upward continuations from those ends of the anterior transverse ridge (*f*). The middle of the hind surface of the front lobe (Plate XL. fig. 7, *a*) is pro-minent, making the masticatory surface widest at that part. The prominence (*b*) from the opposite surface of the hind lobe looks more like an infolding of the outer border of that lobe, a character exaggerated in most Kangaroos; the inner border of the hind lobe is slightly produced backward as well as forward. The hind surface of the hind lobe does not show the mid prominence. The hind transverse basal ridge (*g*) is highest and thickest at its middle; the ends of this ridge are less distinctly continued upon the corresponding borders of the hind lobe than in *m* 2. The slight backward curve of the lobes appears in the profile view of *m* 1, fig. 5.

In the older jaw the lobes of *m* 1 (Plate XL. fig. 9) are worn down nearly to their bases. The front transverse ridge rises a little above the hind one of the antecedent tooth; about 5 lines extent of the fore part of the front lobe rises above the ridge. The anterior enamel-line of the worn surface is nearly straight, the posterior one forms a low angle answering to the prominence of that surface of the lobe. The valley between the two lobes is most shallow and narrow at its middle. The abraded surface of the hind lobe is transversely elliptical, 1 inch $4\frac{1}{2}$ lines in transverse dia-meter, and 8 lines in the opposite diameter; its hind border is worn down within 3 lines of the posterior basal ridge (*g*), which abuts against the next tooth above its anterior ridge.

The fourth molar (*m* 2) in the younger specimen (Plate XL. figs. 9 & 10) has a line of dentine exposed on the summit of the front lobe (*a*), but the enamel is not worn off that of the hind lobe (*b*). The transverse concavity of the fore part of the front lobe is well marked at the present early stage of attrition: the convexity of the back part increases towards the base of the mid prominence. The ends of the front basal ridge (*f*) rise a little way upon the outer and inner borders of the front lobe. The transverse concavity of the fore part of the hind lobe is narrowed, as it descends, by the reciprocal and pro-gressive inbending of the outer and inner borders of the lobe upon the front surface, as this approaches the base of the lobe. The height of the hind lobe from the middle of the valley is 1 inch 3 lines; the antero-posterior extent of the middle of the base of the lobe is 10 lines. The posterior basal ridge (*g*) resembles that of *m* 1, bearing the same proportion to the front ridge.

In the older specimen (ib. fig. 11) the two lobes of $m\,2$ are half worn down; the abraded surface of each is gently bent with the concavity forward; the transverse extent of such surface is 1 inch 7 lines; the fore-and-aft extent of the tooth is 2 inches 4 lines. The abraded surfaces slope from before downward and backward.

In the last molar of the same lower jaw the summit of the hind lobe, on which a narrow tract of dentine is exposed, measures 1 inch 4 lines in transverse extent, that of the more worn front lobe being 1 inch 6 lines. The transverse extent of the base of each lobe is the same, viz. 1 inch 7 lines. The summit of the hind transverse ridge (g) is continuous with a short low rising upon the back part of the hind lobe. The antero-posterior extent of the tooth is 2 inches 5 lines.

There is less difference between $m\,2$ and $m\,3$ of the lower jaw than in the upper one. Owing to the direction of the plane of attrition, the front surface of each worn lobe is higher than the back surface; the front lobe, when unworn, rises a little higher than the back one. The fore part of each tooth rises more abruptly, and in a greater degree above the back part of the tooth in advance; thus the line of attrition of the entire molar series is zigzag. The general curve of the grinding-surface of the four molars is slightly concave from before backward, as, above, it is convex. The contour of the outer sides of the lower series of molars is slightly convex; that of their inner sides is almost straight.

In the mandible belonging to the skull (Plate XXXV. fig. 1) the outer part of $m\,2$ is worn to its base, and a larger proportion of $m\,3$ alone remains in the left ramus*. The fore-and-aft extent of $m\,3$ is 2 inches 5 lines: the same extent of the abraded surface of the front lobe is 9 lines, its transverse extent being 1 inch 7 lines. The enamel at this part of the tooth is fully a line in thickness.

In a fragment of the left mandibular ramus of an old *Diprotodon* are the last two grinders (Plate XL. figs. 17, 18), similarly worn down but better preserved. In $m\,2$ (fig. 17) a portion of the enamel at the inner end of the valley (e), and the enamel of the hind part of the base of the hind lobe with the contiguous basal ridge alone remain; the rest of the surface is polished dentine and osteo-dentine with the external cement. In $m\,3$ (fig. 18) the enamel is worn away from the fore and outer part of the front lobe; the front basal ridge is rounded off; the outer boundary of the valley connecting there the front and hind lobes is smoothed down, and the middle of the hind transverse ridge is touched. Both lobes are worn down nearly to the bottom of the valley. At the middle of each of the smooth concave plates of dentine, a central tract of osteo-dentine (o) is defined. The antero-posterior extent of $m\,2$ is 2 inches 4 lines; that of $m\,3$ is 2 inches 5 lines; the greatest transverse diameter in each is 1 inch 7 lines. This *Diprotodon* had probably died of old age. The outer alveolar border has grown upward with the rise of the fangs and base of the teeth to bring them into grinding contact with those of the upper jaw.

In the crown of the last molar not wholly emerged from the formative alveolus of the

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* The form and position of these teeth are given, in outline, from better preserved and less worn specimens.

young *Diprotodon* (Plate XL. figs. 12, 16), the unworn summit of the hind lobe is irregularly and minutely wrinkled, not divided into small mammilloid tubercles as in the Dinothere.   In the largest existing species of Kangaroo (*Macropus major* and *M. laniger*, e. g.) the lower molars have no posterior basal ridge.   It is interesting to find that this is present in a still larger extinct species (*Macropus atlas*, Ow., fig. 14, *g*), but it is narrower than the anterior basal ridge.   In the lower molars of *Diprotodon* the posterior basal ridge is not only constant, but is broader than the anterior one.

The sum of the characters of the teeth of *Diprotodon*, and the observed varieties and modifications due to sex, age, and other conditions, have been given in detail and fully illustrated.   The most common evidences of extinct Mammals are detached teeth; and it seemed desirable to afford sufficient and satisfactory means of determining those of the genus *Diprotodon*, as thereby the knowledge of its geographical distribution in the Australian Continent at the period of its existence may be the more speedily acquired.

A retrospect of the dentition exhibited in the series of specimens above described and illustrated brings to view a combination of characters now shown apart in the marsupial herbivorous genera *Macropus* and *Phascolomys*; but the Macropode characters prevail in number and importance.   The small upper incisors (*i* 2 and *i* 3) with definable crown and fang and concomitant limitation of growth, the same genetic character of the molars with the bilophodont type of their crown, testify to the closer affinity of *Diprotodon* to *Macropus*.   The large, scalpriform, ever-growing first pair of incisors of the upper jaw, with the shape, structure, and corresponding genetic character of the lower pair of incisors, are resemblances to the Wombat's dentition; and the same affinity is exemplified in the number of the molar teeth.

In the Macropode group, although not more than five grinders are ever in place in one alveolar series of either jaw, seven may be developed.   Of these teeth two have no homologues calcified in either *Phascolomys* or *Diprotodon*; these are the small anterior teeth symbolized in my 'Anatomy of Vertebrates' (vol. iii. p. 380, fig. 296) as *d* 2 and *p* 3 (Cut, fig. 4).   It may be objected that, for certainty on this point, one ought to have specimens of jaws of *Diprotodon* of an earlier age than that represented in Plates XLI. & XLII.   My experience in marsupial dentition begets confidence, however, that, had a true "replacing tooth" been developed in *Diprotodon* as in *Macropus*, its crown-germ would have been detected beneath the tooth marked *d* 3, in the subject of the above-cited Plates.   I also believe that, had a *d* 2 ever been calcified and in use, as in the Kangaroos and Potoroons, some trace of its alveolus would have remained, in this young jaw, instead of the continuous, even subtrenchant margin which the diastema of the subject of Plate XLI. presents between *d* 3 and *i*.

Since the Wombats in their molar dentition offer precisely the same differences as to number and succession of grinders which *Diprotodon* presents, we may have the less reserve in accepting the evidences of the further resemblance which the molar series adds to the incisive one.   The extension of the genetic character of the scalpriform incisors

to the molars is the marked distinction of *Phascolomys* in the Marsupial series; for, with continuous growth, go length of tooth without loss of breadth, depth of implantation with, commonly, curvature of socket, and continuation of enamel to the widely open base of the tooth. I have no evidence that the first and smallest of the series of five grinders in *Phascolomys* is a premolar or replacing tooth, and view it, therefore, as one of the first developed calcified series. It is analogous, in function, in retention, and long-continued use, to a premolar of the placental type-dentition. The succeeding four grinders in both *Phascolomys* and *Diprotodon* are equally members of the first set of teeth; and the last three are homologous with those that are not displaced by vertical successors in diphyodont *Placentalia*. The symbols, therefore, $d\,3$, $d\,4$, $m\,1$, $m\,2$, $m\,3$, express, in my opinion, the homologies of the functional molar teeth of *Diprotodon* with those, *e. g.*, so marked in *Hyrax*, *Hippopotamus*, and *Sus**. For convenience of comprehension of the teeth symbolized in Plates XXXV.–XLII. I subjoin woodcuts of an instructive phase of dentition in the Hog (fig. 3) and Kangaroo (fig. 4).

Figs. 3 & 4.
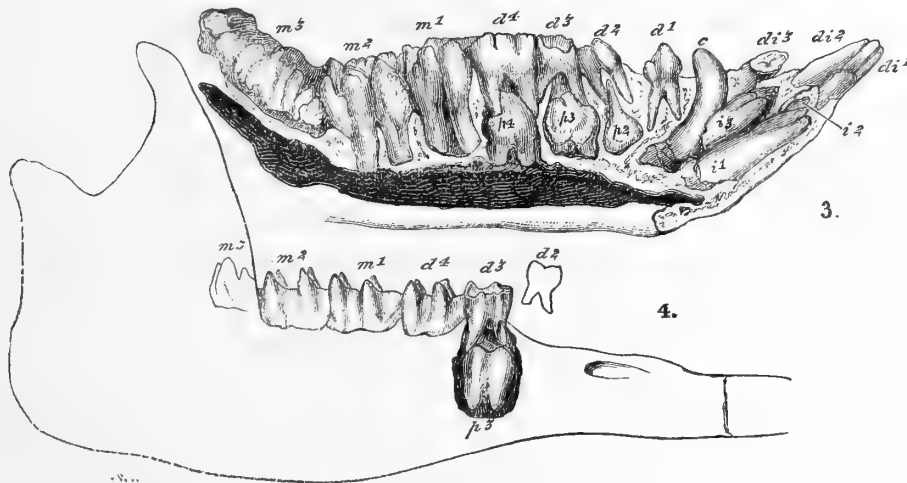
§ 5. *Spinal Column.*—Of the atlas there is a portion of the left moiety (Plate XLIII. fig. 2) showing the deep articular cavity for the occipital condyle of the same side, between which and the diapophysis is the outlet of a canal (*a*) about 3 lines in diameter, which traverses the neural arch from within outward behind the upper part of the cavity for the condyle. The surface (z') for the articular process of the axis is slightly concave; between its upper part and the ridge leading from the hind margin of the neural arch to that of the diapophysis there is a deep and wide groove for the passage of the vertebral artery into the neural canal. The above-described fragment yields evidence that, as in *Macropus*, *Phascolomys*, *Phascolarctos*, and some other Marsupials, the ring of the atlas (if indeed it were completed below by bone in *Diprotodon*) presented only the perforation

* In my 'Anatomy of Vertebrates,' vol. ii. p. 465, fig. 312; vol. iii. p. 346, fig. 276; p. 357, fig. 287; p. 377, fig. 294.

(for the anterior spinal nerve or a division of it) on each side of the base of the neural arch, the vertebrarterial canal being, as above described, an open groove. In the atlas of proboscidian and of other large placental Mammals, which the present fossil resembles in size, the diapophyses are widely bored by the vertebral artery, which usually perforates also the fore part of the neurapophysis*.

I recognize, therefore, in the portion of the atlas vertebra, here referred to *Diprotodon*, marsupial characteristics; compared with that of the Kangaroo, its diapophyses are relatively shorter, thicker, terminally more obtuse, not so much expanded or depressed at that part, upon the whole more resembling those in the Wombat and Koala†.

The axis or vertebra dentata (Plates XLIII. fig. 1, & XLIV. figs. 1, 2, 3) is entire save the ends of the diapophyses, which have been broken away. The length of the body, with the odontoid process, is 6 inches 3 lines, the height of the vertebra is 8 inches 4 lines, the breadth across the anterior articular surfaces is 5 inches 9 lines. The size of this vertebra thus equals that in the largest Rhinoceros or Hippopotamus, and in length that of a full-sized Elephant. The hind surface of the centrum (Plate XLIV. fig. 3, *c*) is flat, rather rough, transversely elliptic, with a tendency to an angular or octagonal outline. The under surface (ib. fig. 2) expands as it advances to develope the bases of the parapophyses (ib. *p p*); contracting in advance of these it again expands into the anterior articular processes (ib. and fig. 1, *z, z*). A low hypapophysis (ib. fig. 2, *hy*) of a subtriangular form projects from the middle of the under surface towards the fore part. The anterior articular surfaces (Plates XLIII. & XLIV. fig. 1, *z*) converge to the base of the coalesced body of the atlas, called "odontoid" process. This element (Plate XLIII. fig. 1, *ca*, and Plate XLIV. fig. 2, *ca*), 2 inches in length, 1 inch 6 lines in breadth, and of similar depth, is convex transversely and longitudinally below; it has a pair of slightly concave roughened surfaces, meeting above, along the anterior sloping half (Plate XLIII. fig. 1, *m*), behind which the upper surface rises into a low broad tuberosity (ib. *t*), bounding anteriorly a smoothish elliptical surface (ib. *r*) occupying the upper part of the rest of the odontoid. A broad deep irregular depression (ib. *o*) divides this surface of the odontoid from the anterior articular surfaces of the axis. These surfaces (ib. and Plate XLIV. fig. 1, *z, z*), of a full oval shape, 3 inches in diameter, are moderately convex. The neurapophyses (Plate XLIII. *n*), after developing the diapophysis (ib. *d*), contract to a fore-and-aft extent of 1 inch 9 lines, then expand backward to develope the postzygapophyses (*z'*), in advance of and between which the neurapophyses converge and coalesce to form the base of the neural spine (ib. *ns*). This expands both forward and backward,

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* Osteological Catalogue of the Museum of the Royal College of Surgeons, 4to, 1853, p. 475, no. 2678, 'Atlas of Elephant' (by misprint the vertebral artery is called "medullary"); p. 509, no. 2945, 'Atlas of *Rhinoceros bicornis*,' "the vertebral artery perforates the diapophysis and then also the neural arch;" p. 566, no. 3404, *Hippopotamus amphibius*, "the transverse processes are perforated by the vertebral arteries."

† I am led to believe, after fresh study of Diprotodont fossils, that the one ascribed to a calcaneum in my 'Catalogue of Fossil Mammalia in the Museum of the Royal College of Surgeons' may be a fragment somewhat rolled and worn of the atlas vertebra.

as it ascends, to an obliquely truncate summit nearly 5 inches in fore-and-aft extent; narrow and ridge-like at the mid part, expanding and obtuse at the fore and hind angles, the latter being the thickest; from each side of this angle a low ridge (Plate XLIII. fig. 1, *g*) descends obliquely forward, subsiding upon the lateral surface of the spine. The neural canal is 2 inches 3 lines in width, and rather less in height, especially behind, where the vertical diameter is 1 inch 6 lines. A wide groove leads outward and downward from the canal between the postzygapophyses and the back part of the centrum. The upper (neural) surface of the centrum is impressed at its middle with a deep pit, to which a groove leads on each side; the smooth surface has been broken away before and behind the pit, indicative of its having been crossed lengthwise by a bony bar, which would have converted the lateral groove into a pair of foramina.

Of the quadrupeds resembling in size the *Diprotodon*, the Proboscidians have the axis most like that of the Australian giant, but the following differences present themselves. In *Elephas* the odontoid is absolutely, as well as relatively shorter; the anterior articular surfaces are less uniformly convex and less convex in any direction; the neural spine is relatively lower, much thicker transversely, with a subquadrate termination or upper surface, canaliculate along the mid line, and deepening to produce a posterior bifurcation. The centrum has no hypapophysis. In *Macropus*, on the other hand, we find the hypapophysis is repeated both as to size and position; the odontoid process also offers a like development, with resemblance in such details as the disposition and proportions of the pair of upper terminal surfaces for ligamentous attachment, and the posterior smooth surface for the transverse ligament. The neural spine is, however, more produced anteriorly and less so behind.

In my 'Osteology of Marsupialia,' I noted, as a result of observations on the skeleton of *Macropus major*, that "in the Kangaroo both the dentata and atlas have the transverse processes grooved merely by the vertebral artery"[*]. I have since observed in *Macropus laniger* the circumscription of the groove by the development of a slender parapophysis, as in *Diprotodon*. A similar vertebrarterial canal occurs in *Phascolomys* and *Phascolarctos*. The neural spine of the axis in the Wombat resembles in shape that in the *Diprotodon*, but is rather more produced behind. The hypapophysis is, however, a mere medial low ridge; that in the Kangaroo is significantly more like the process in *Diprotodon*. In both *Macropus*, *Phascolomys*, and *Phascolarctos* a pair of conspicuous foramina near the hind part of the upper (neural) surface of the centrum lead to canals converging as they sink in the osseous substance to a common (venous) passage; these are not present in Proboscidians; a few minute irregular venous foramina may be seen on the corresponding surface of the axis vertebra.

The third (Plate XLIV. fig. 4) and two consecutive (Cut. fig. 5, *c* 3, *c* 4) cervical vertebræ resemble by their shortness those of the Wombat rather than of the Kangaroo; they are by no means, however, so compressed from before backward as in the Proboscidians.

[*] Trans. Zool. Soc. vol. ii. p. 394; see also Art. *Marsupialia*, Cycl. of Anat. p. 276.

In *Diprotodon* the length of the third cervical centrum is 1 inch 10 lines, the breadth of its hind articular surface is 4 inches 3 lines, the height of the vertebra is 8 inches. The centrum is without hypapophysis, the vertical extent of the hind surface (Plate XLIV. fig. 4, *c*) is 2 inches 9 lines; the two extremes of the transverse ellipse are almost angular. The base of the parapophysis (ib. and cut, fig. 5, *p*) extends from near this angle forward for 1½ inch along the side of the centrum. The upper surface of the centrum shows a large medial venous orifice. Both margins of the rising neurapophyses are deeply notched for the "conjugational foramina," and send off a small diapophysis (ib. *d*) to circumscribe above the vertebrarterial canal. The neural spine (ib. *ns*), 4 inches in height from the roof of the neural canal (ib. *n*), is compressed from before backward, simple, obtusely rounded at the end, strengthened by a low medial ridge, both before and behind, along its basal half. There is no such development of neural spine in the third cervical of Proboscidians; in the larger herbivorous Marsupials it is as conspicuous as in *Diprotodon*, but with altered shape; that in the Wombat most resembling the one in *Diprotodon*, but being relatively lower.
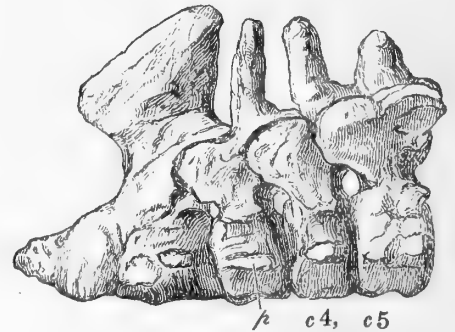
The fourth cervical (Cut, fig. 5, *c* 4) much resembles the third; but, as in the Kangaroo, has a shorter spine, resembling, however, in shape that of the third, being compressed from before backward instead of from side to side as in *Macropus*. The slight increase of size is in breadth, chiefly of the centrum, not in length or height. The neural canal is wider and a little higher; more space is made for the myelon as it traverses the more flexible part of the neck. The large venous foramina and vertical canal are repeated on the upper part of the centrum; the corresponding pair of foramina now also blend into a common fossa, as in the Wombat.

In the fifth cervical (Cut, fig. 5, *c* 5) the neural spine gains in antero-posterior and loses in transverse thickness; the vertical ridges are stronger, especially the one behind; it appears to have been shorter than in the fourth vertebra*. The centrum and neural canal have increased, chiefly transversely; there is very little increase of length. The parapophysis has gained in vertical extent.

In the series of mutilated vertebræ belonging to Mr. BOYD's specimen of *Diprotodon* are two dorsals (Plate XLIV. figs. 5–8). They show the impressions for the free articulation of the ribs both before and behind (ib. figs. 6 & 7, *pl, pl'*), and are remarkable

Fig. 5.

p   *c* 4,   *c* 5

Second to fifth cervical vertebræ, one-sixth nat. size; *Diprotodon.*

for the retention of the short proportion of the cervicals, and for the terminal bifurcation of the antero-posteriorly compressed spine (ib. figs. 5 & 8, *ns*). They are not consecutive vertebræ, but were not far from one another in the anterior part of the dorsal series.

* It is so in the sketch sent me by Sir THOMAS MITCHELL from Sydney (Cut, fig. 5); but, amongst the damages to the specimens in their passage to London, the summit of this spine has been knocked off.

As in this region the vertebræ in many Mammals decrease in breadth before regaining the size which then goes on augmenting to the lumbar region, I first take for description that (Plate XLIV. figs. 5 & 6) which with a broader centrum has a shorter as well as broader spine.   The fore-and-aft extent of the centrum is 2 inches at its lower part; it slightly decreases towards its upper surface.   The breadth of the centrum is 4 inches 10 lines, above which this dimension is increased by the share contributed by the neurapophyses (ib. fig. 5, n, n) to the body of the vertebra (c); the sutural lines indicative of this share are plainly traceable on the terminal articular surface (ib. fig. 5, c), from which the epiphysial plate has become detached.   As the ends of both diapophyses and neural spines are broken off, the following dimensions of the vertebra are not the full ones, viz. of breadth 8 inches 6 lines, of height 9 inches 6 lines.   The width of the neural canal is nearly 4 inches, its height is fully 3 inches.   Both articular surfaces of the centrum are nearly flat, the anterior one in a very slight degree convex; but both surfaces are epiphysial, with coarse furrows and lines affecting a radiate disposition, the extent of which rugosity indicates the complementary plate to have overlapped both elements of the vertebral body, viz. the neurapophysial (fig. 5, n, n) and the central one (ib. c)[*].

A prominence on the upper third of the side of the body indicates the lower boundary of the neurapophysis, and this part of the body holds the main part of the impressions (pl, pl') for the head of the rib, of which impressions the hinder is the larger.   The contour of the articular surfaces of the body is semicircular.   The neurapophyses, after contributing their share to the vertebral body, extend upward, outward, and a little forward, contracting into subcylindrical pedicles which suddenly expand to send off the diapophyses (ib. figs. 5 & 6, d), prezygapophyses (z), and postzygapophyses (z'). Before developing the latter processes the neurapophyses begin to bend inward, still ascending; then they contract, especially from before backward, converge, and coalesce to form the base of the antero-posteriorly compressed and laterally expanded spine (ns). The base of this spine is strengthened both before and behind by a low broad median ridge; its terminal divisions diverge as they rise.   The undivided base forms a low obtuse eminence between them (fig. 5, ns).

The prezygapophysis (fig. 6, z) projects forward as a semicircular shelf, the flat articular surface looking upward, with a very slight inclination downward and outward; the postzygapophyses (z'), of somewhat smaller size, are supported each by a buttress of bone descending from the hinder and outer angle of the spine, and expanding with a prominent convexity to the articular surface.   The upper surface of the centrum, between the neurapophysial bases, shows the large venous fossa.

In the other dorsal vertebra (Plate XLIV. figs. 7, 8) the diapophysis is entire on the left side (fig. 8, d), and expands into a protuberance with an articular surface (fig. 7, d) 1 inch 9 lines by 1 inch 3 lines, for the tubercle of the rib on its lower half.   The neurapophysial parts of the centrum are traceable, and make a more definite rising at

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[*] This is the usual character of epiphyses completing compound bones, as, $e. g.$, at the proximal end of the three confluent metatarsals in the bird, at both ends of the two confluent metacarpals in the ruminant, &c.

the upper part on each side the small intervening proportion of the centrum proper (ib. fig. 8, *c*).   Posteriorly they also slightly project (fig. 7, *n*) beyond the flat surface of the centrum (ib. *c*); and a smooth tract of the neural canal (fig. 8, *n'*, *n'*) is continued backward upon each of these prominences.   The fore surface of the centrum is in a very slight degree convex; both surfaces are epiphysial or rough, with the usual tendency to a radiate disposition of the fine furrows.   The postzygapophyses (*z'*) are somewhat more prominent than in the former dorsal (figs. 5 & 6), and the neural spine slopes a little backward.   This process is narrower transversely than in fig. 5, and is longer prior to its bifurcation (fig. 8, *ns*).   Its strengthening ridges, especially the anterior one, are more developed; the bifurcation of the summit is repeated in this as in the foregoing vertebra, with slight divergence of the terminal prongs, both of which have lost their summits.

In the whole range of the Mammalian series I know of no dorsal vertebræ with characters like the subjects of figures 5–8.   Where vertebræ are notable for their shortness and lamelliform type they are confined to the region of the neck, as, *e. g.*, in *Proboscidia* and *Cetacea*; but the dorsal series, in these, promptly resumes the ordinary proportions of length of centrum.   Similarly, where the transversely bifurcate character of the neural spine is met with (*e. g.* Elephant, Man), it is restricted to one or two of the cervical series; in *Diprotodon* only is it known to exist in a dorsal vertebra.   What modification may ensue or at what distance from the neck in other or posterior dorsal vertebræ my present materials do not enable me to state.   I infer that the more usual proportions are acquired in the posterior dorsals from the slight increase presented in the following specimen, and from those which certain of the lumbar vertebræ present.

The specimen referred to, which forms part of the collection in the Museum of the Royal College of Surgeons, consists of the centrum only.

It measures 2 inches 3 lines in antero-posterior diameter, 3 inches in vertical diameter, and 4 inches 9 lines in transverse diameter.   Both articular extremities are flat; the epiphysial plates are anchylosed; but where they are broken away the radiating rough lines, characteristic of the epiphysial surface, indicate that the union was tardy and had been recently effected before the animal perished.   This vertebra differs by its compressed form and the flattening of the articular ends from the dorsal vertebræ of the ordinary placental Pachyderms, but resembles in these characters the dorsal vertebræ of the Proboscidians; in these, however, the breadth of the vertebral body is not so great as in the fossil.   From the cetacean vertebræ the present fossil is distinguished by the large concave articular surface at the upper and anterior part of the side of the body for the reception of part of the head of a rib; this costal surface, which is not quite entire, appears to have been about $1\frac{1}{2}$ inch in diameter.   The neurapophyses are anchylosed to the centrum, but the internal margins of their expanded bases are definable, and have been separated by a tract rather less than 1 inch in breadth, of the upper surface of the centrum; at the middle of this surface there is a deep transversely oblong depression.   A similar depression is present in some dorsal vertebræ of the *Megatherium* and in the

anchylosed lumbar vertebra of the *Mylodon*; but the bodies of the dorsal vertebræ in the great extinct *Bruta* are longer and narrower in proportion to their breadth than in the present fossil. In the Kangaroo the upper surface of the body of the dorsal and lumbar vertebræ is perforated by two vascular canals, which pass down vertically and open below by a single or double outlet. In the Wombat the middle of the upper surface of the bodies of the dorsal and lumbar vertebræ exhibits a single large and deep depression, which in the dorsal vertebræ has no inferior outlet, and in this character they closely resemble the present fossil. The dorsal vertebræ of the Wombat are, however, longer in proportion to their breadth.

Thus the present mutilated vertebra alone would support the conclusion that there had formerly existed in Australia a mammiferous quadruped, superior to the Rhinoceros in bulk, and distinct from any known species of corresponding size. It is interesting and instructive to find one well-marked character in it, viz. the median excavation on the upper part of the body, repeated in the same vertebræ of one of the largest of the existing *Marsupialia*.

The remaining evidences of vertebræ in the Boydian or purchased series of Diprotodont Fossils in the British Museum consist of five centrums and two pairs of detached terminal epiphyses of those elements.

The centrums, in the absence of any costal or hæmapophysial depression, in their increased length and greater expanse of the neural canal, are referable to the lumbar series. Three retain the coalesced bases of the neurapophyses, yet these do not develope diapophyses in the extent to which they are preserved.

The foremost of these lumbar centrums shows a length of 2 inches 4 lines at its lower part, increasing to 2 inches 8 lines at its upper part; the others, with slight general gain of size, show the same proportions. Thus the one which seems the last of the series has a length of 3 inches 3 lines at the lower part, and of 3 inches 8 lines at the upper part of the centrum. Thus we may infer that the part of the spine from which these vertebræ have come was habitually bent in *Diprotodon* with the concavity downward. The degree of increased length in the last over the longest of the other three centrums indicates two or three missing vertebræ intervening between those to hand. The Kangaroo has six lumbar vertebræ, the Koala eight, the Wombats only four (*Phascolomys vombatus*) or five (*Phascolomys latifrons*). Six lumbars is the rule in *Marsupialia*, and I incline to view *Diprotodon* as amenable thereto, rather than as repeating the exceptional formula of *Phascolomys**.

In the foremost of the five fossil lumbar centrums a small protuberance from the upper and fore part of one side indicates the rudiment of a diapophysis; it is not present on

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* As I was led to note in my 'Osteology of *Marsupialia*,' *loc. cit.*, p. 396, the number of free trunk-vertebræ is significantly constant in that order, whatever be the difference of costal formula ; thus, *Phascolarctos* has 11 costal, 8 lumbar, =19 ; *Petaurus*, 12 costal, 7 lumbar, =19 ; *Macropus, Phalangista, Perameles, Myrmecobius, Phascogale, Didelphys, Dasyurus, Sarcophilus, Thylacinus*, have severally 13 costal, 7 lumbar, =19 ; *Phascolomys vombatus* has 15 costal, 4 lumbar =19.

the other side; it may be a vertebra, as is sometimes seen in the Kangaroo and other mammals, transitional between the dorsal and lumbar series, having the characters of a rib-bearer on one side and not on the other. A trace of roughness on the side of the fossil centrum corresponding to the protuberance on the other side, may indicate there a ligamentous attachment of a rudiment of the last free rib. The present vertebra, whether interpreted as the last dorsal or first lumbar, shows the small extent to which those vertebræ gained in length as they receded in position. The antero-posterior diameter at the under part of the centrum is 2 inches 5 lines, at the upper part 2 inches 10 lines; the breadth of the anterior surface is 4 inches 10 lines, the vertical diameter of the same surface is 3 inches 9 lines. The epiphysial plate adheres to this surface; it is concentrically marked, thinning off to the centre, where it leaves a vacuity transversely oblong, 1 inch 4 lines by 1 inch in its diameters. From the opposite surface the epiphysis has been detached, showing the radiate disposition of the rugæ of the diaphysial surface, and the proportions contributed by the bases of the neurapophyses to the vertebral body.

In the next vertebral body, of similar dimensions, the anterior epiphysis is adherent, but with the line of suture conspicuous; it is from 3 to 4 lines thick at the periphery, and thins off toward the centre, where it leaves a vacuity of about 1 inch in diameter. The surface, for 1 inch at the periphery, is moderately convex, the rest is flat. The free surface of the centrum is greatly and equably concave lengthwise. At the middle of the neural surface is a transversely oblong venous fossa, 9 lines by 6 lines in diameters. This centrum adheres by matrix to the succeeding one, which, repeating the characters above noted, retains about 1 inch of the neurapophysial pedicles or lamellæ. Each at its origin has a fore-and-aft extent of 2 inches, contracting to 1 inch 8 lines at the fractured end; it rises nearer the fore than the hind end of the centrum. The extreme thickness (1 inch) is toward the fore part of the pedicle. The transverse diameter of the neural canal at the broken ends of the pedicles is 3 inches 6 lines. The venous fossa is repeated in this as a single median one; but in another lumbar centrum the entry is divided by a median longitudinal tract of the neural surface, as is commonly the case in the Kangaroo.

In the third of these the left pedicle is preserved to a height of 2 inches, expanding then to an antero-posterior extent of 2 inches 3 lines, and a transverse one of 1 inch 5 lines; at the lower contracted part of the neurapophysis these diameters are, respectively, 1 inch 9 lines and 1 inch. Yet the whole of the outer surface is smooth without trace of outstanding transverse process; whereas in both Kangaroo and Wombat that process comes off at the junction of the neurapophysis with the centrum. We may therefore infer that the neural arch of the lumbar series was loftier in *Diprotodon*, as we have already seen it to have been in the two anterior dorsal vertebræ preserved. The epiphysis is wanting from the hind surface of the third lumbar described, and the sutures of the neurapophyses with the centrum are there exposed. They project a little beyond the epiphysial surface of the centrum. The largest and hindmost of the present series of lumbars (Plate XLIV.

figs. 9, 10), the length of the centrum of which has been noted above, shows a breadth of hind surface (fig. 10) of 5 inches 9 lines, its height being 4 inches; the antero-posterior extent of the base of the pedicle is 2 inches 6 lines; about 9 lines extent of the centrum extends backward beyond it.

The smaller pair of epiphysial vertebral plates (ib. fig. 12), cemented together by the matrix, have come, according to their size and shape, from the cervical series; they are transversely elliptical, 4 inches 6 lines in long diameter, and 3 inches in short diameter. The thicker free or peripheral margins (12, a) diverge from each other, and they thin off to a central vacuity (12, c). The larger pair (ib. fig. 13) appear to be from the lumbar series; they measure 4 inches $7\frac{1}{2}$ lines across, and 3 inches 8 lines down the middle; their central vacuity is transversely oblong, measuring 1 inch 3 lines by 1 inch. These detached vertebral epiphyses are completely petrified.

The terminal epiphyses of the bodies of dorsal and lumbar vertebræ remain distinct, and come off in pairs attached by intervertebral substance in Kangaroos which have arrived at full growth. I presume that the same circumstance occurred in the course of decomposition or maceration of the carcass and skeleton of *Diprotodon*; hence the presence of such separate pairs of epiphyses receiving co-attachment from the matrix after separation from their proper centrums[*].

Of the ribs, though few are entire, so many have reached me as suffice to show that,

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[*] Since the reception of the specimens of vertebræ above described, I have been favoured with two drawings, of the natural size, of a side view and end view of a lumbar vertebra of a *Diprotodon*, from St. Ruth's Station, Condamine River, Queensland, by Dr. Fr. Campbell. In these drawings sufficient of the neural arch is preserved to show the base of the diapophysis extending outward, at 1 inch 6 lines above the level of the upper surface of the centrum. The breadth of the centrum is 5 inches, its vertical diameter 4 inches; the breadth of the neural canal is 3 inches 6 lines, the fore-and-aft extent of the centrum at its upper third is 2 inches 10 lines. An oblique broad low ridge or rising of the outer surface of the pedicle rises to the lower part of the base of the neurapophysis.

The two drawings, of side and front views, of this vertebra have been made carefully, and I believe accurately, as regards admeasurements, by Mr. Campbell's son, who found the vertebra, and whose letter to his father on the subject is as follows:—

<div align="center">(Copy.)</div>

<div align="right">" St. Ruth, 25th May, 1865.</div>

" The enclosed drawings I send to you to amuse you a little till I come down, speculating as to what the huge animal was. I have the bone and some more, now in my possession. A large top jaw with a few pieces of teeth sticking in it, and what looks like a *blow-hole* in the top—some smaller shank bones, or something of the sort—all fossil. They ring like cast iron when knocked together: too heavy to bring down with me:—they are of a dark brick colour. I will try and make drawings of the rest if I have time before I come down. One of the vertebræ of a Bull looks very small indeed alongside this great bone.

<div align="right">(Signed)   " Hugh Campbell."</div>

In the letter inclosing his son's drawings Dr. C. writes:—" The bones he mentions in the letter and whose likeness is also inclosed herewith, I regret to say he was induced to part with to a gentleman to whom he was under particular obligations of friendship, and who had expressed a great desire to possess them." Should the present notice ever meet the eyes of the possessor of these fossils he may be assured that it would give me pleasure to make them subservient to the advancement of a knowledge of *Diprotodon*.

as in Marsupials and most Mammals, they vary in length, curvature, degree in which the groove for the intercostal vessels and nerve is excavated, distinction of head and tubercle, and relative position of the latter (Plate L. *pl* 1—14).

The longest specimen measures 2 feet 1 inch, following the convexity of its curve. The tubercle is low, $3\frac{1}{2}$ inches from the head; the intercostal groove is shallow, and chiefly defined by a ridge-like production of the posterior border at the upper fourth of the rib, 3 or 4 inches in extent. Beyond this the rib loses thickness and gains breadth, the latter dimension reaching to $1\frac{1}{2}$ inch about one-third from the broken end.

Another specimen presents a greater degree of curvature. The tubercle is better developed, has a more definite articular surface, extending upon the neck of the rib. The broadest part of the rib (1 inch 9 lines) is at the upper third of the bone. This rib had a more anterior position in the chest than the former; the extent preserved, following the convexity of the curve, is 1 foot $6\frac{1}{2}$ inches.

A third specimen with head, tubercle, and intercostal groove well marked, is less curved than the former, and is larger than either of the above described. A length of 1 foot 4 inches is preserved. The fractured end is elliptic, 1 inch 9 lines in long diameter, 1 inch in short diameter; but the rib midway between the end and the head attains a breadth of 2 inches. This has come from nearer the middle of the chest.

The only entire specimen is a posterior rib, with the tuberosity relatively small and rough; the head large, intercostal groove almost obsolete; body of the rib straight along its distal half, which gradually expands, with loss of thickness to a breadth of 2 inches 2 lines. The length of this rib, following the convex curve, is 1 foot 8 inches. The lower extremity shows the roughened surface for the attachment of the costal cartilage.

The costal fragments yield little more than the character of size. The vertebral end of one, which includes the tubercle, has a circumference below that part of $3\frac{1}{2}$ inches. Another fragment has a circumference of $4\frac{1}{2}$ inches; a third fragment is nearly 6 inches in circumference; a fourth fragment shows a flatter shape.

From the shortness of the costigerous vertebræ and the size of the ribs, their interspaces must have been narrow.

Assuming with much confidence that the dorso-lumbar series in *Diprotodon* included nineteen vertebræ, I assign one more pair of ribs than in the Kangaroo, and reckon fourteen pairs in the dorsal series (Plate L.).

§ 6. *Scapula.*—The scapula is represented in the Boydian collection of Diprotodont remains by an almost entire specimen of that of the left side (Plate XLV.), and by a fragment of the one of the right side.

It is narrow in proportion to its length, and chiefly peculiar by the production of the subspinal plate anteriorly (ib. *a*), whereby the usual proportions of the triangular mammalian scapula are reversed, the part answering to the base (ib. *b*) being the apex, and

the articular end of the bone (ib. *a, c*) the base of the triangle, which is elongate and irregular.

The articular or glenoid cavity (ib. *d*) presents the usual oval shape with the small end upward (ib. fig. 3); the concavity is deepest lengthwise, and the apical part is most produced. The outer border beneath the acromion (*e*) has been broken off, indicative of its prominence, which is better preserved in the articular cavity of the fragment of the right scapula, showing its resemblance to that part in *Macropus*. This border subsides, becoming thick and convex as it approaches the small or coracoid end of the cavity. The lower border is continued into a rugged triangular surface beneath (fig. 3, *a*) for the attachment of the long head of the triceps; the upper apical part is produced, beak-like, beyond the base of the coracoid (*c*). The inner margin is low near the apex, but less obtuse than the corresponding part of the outer one; it is more produced as it descends; but this margin subsides gradually into the subscapular one.

The spine (ib. fig. 1, *f*) begins by a gradual elevation of the lower or hinder half of the hinder surface of the "base" (*b*), which elevation contracts as it rises from that surface to a thickness of 1½ inch. The free border, of this thickness, is also flat; the spine gradually rising as it advances, describes a slight curve toward the upper or anterior costa (*g*); the lower margin of the free border becomes most produced, and, as the spine expands into the acromion (*e*), this margin also expands and becomes rough for muscular attachments, and in the present specimen forms the most prominent part of the acromion; but the end of this process is broken off. From a pencil-sketch of this scapula made by Sir THOMAS MITCHELL when it arrived at Sydney (Woodcut, fig. 6), the acromion (*e*) continued to expand to an obliquely truncate end, having the upper or fore angle most produced, and, as it were, slightly twisted towards the coracoid (*c*) (indicated by the dotted line in fig. 1, Plate XLV.). As the spine (ib. *f*) rises from the scapular plate, it becomes compressed or thinner beneath the free margin, and presents a smooth concave surface to each scapular fossa (*i, j*).

Fig. 6.

Scapula of *Diprotodon*: one-fifth nat. size.

The coracoid process (Plate XLV., c), arising from a base of 3 inches in extent, is sub-compressed, with the outer surface concave as it extends toward the end of the process, which, however, is broken off.   The upper or front "costa" (ib. g) describes a strong concave curve as it recedes from the coracoid; the middle third of its extent (ib. g'), which was probably convex and produced, has been broken away.   Where it is again entire (ib. g'') it describes a gentle concavity, and forms the outer border of a sudden thickening of that part of the basal end of the scapula.   The upper or basal three-fourths of this anterior border of the bladebone are curved "dorsad," so as to bound or form the (transverse) hollow of the supraspinal fossa (ib. fig. 1, i).   The part broken from the upper costa (g') may have made the breadth of the fossa, as in the Kangaroo and most Marsupials, greater at its mid part than appears in this fossil.

The subspinal fossa (ib. j) increases in breadth from the basal (b) to the articular end (a) of the scapula, singularly reversing its proportions in other Mammals.   In the Koala (Phascolarctos) this fossa retains its breadth through an extension of the lower costa nearer to the glenoid cavity than usual*.   The corresponding extension is proportionally greater in the scapula of the Megatherium; but in Diprotodon it is continued as far forward as the neck of the scapula, with an increase of thickness, and a bend toward the "dorsum" of the scapula, increasing the depth of the concavity of this part of the subspinal fossa.   The border of the plate (ib. a, a') produced below or behind the glenoid cavity (d), and having the same aspect, is very thick, concave lengthwise, convex across, with a rough slightly projecting insertional surface at its middle: a more rugged surface appears also at the angle a, where it joins the lower or hinder costa, but this is the seat of some mutilation of the fossil.

This costa (a, b) loses thickness as it recedes from the angle for one-fourth of its extent; it regains a certain thickness and ruggedness for another fourth (k), where it is also bent toward the subscapular plane; it then continues drawing nearer to the origin of the spine and finally thickens as it is lost in the obtuse contracted basal end (b) of the bladebone.

The long and narrow subscapular surface (Plate XLV. fig. 2 l) presents a gentle concavity lengthwise, with a corresponding convexity across the middle, rather increased at the two ends; the mid convexity is changed to a concavity by the in-bending of the part (k) of the lower costa above mentioned   The smooth subscapular surface is broken only by the thick short triangular elevation (ib. m) extending from near the upper or fore angle of the base.

The singular, not to say unique, development of the "glenoidal" part of the inferior costa (a, a') or subspinal plate, was doubtless correlated with some peculiarity of use or application of the fore limb.   As to the general shape of the scapula, I cannot suppress expressing the interest with which I have viewed in this old extinct Marsupial or im-placental form of Mammal the retention of so much of the archetypal or pleurapophysial proportions which one sees without surprise in inferior Vertebrates such as Monotremes, Birds, Reptiles, and Fishes.

* This peculiarity is figured in the 'Cyclopædia of Anatomy,' Art. Marsupialia, p. 281, fig. 106.

The total length of the above described scapula is 2 feet 3 inches; the extreme breadth is 1 foot 2 inches; the long axis of the glenoid cavity is 6 inches, the short axis 4 inches 2 lines; the height of the spine at the base of the acromion is 4 inches.

Fragments of scapula, from the bed of the Condamine River, west of Moreton Bay, Australia, in the Museum of the Royal College of Surgeons, placed with some doubt in the series of Diprotodont remains in my 'Catalogue of Fossil Mammalia' (4to, 1845, p. 298), can now be certainly referred to *Diprotodon australis*. One of these fragments (no. 1471) includes 4 inches of the interior part of the origin of the spine. "The thickness of the neck of the scapula is 2 inches 9 lines; that of the base of the spine is 1 inch. The indication of the sudden rising of this thick spine from the plane of the scapula distinguishes it from that bone in the Rhinoceros, and its thickness is greater than in the largest Hippopotamus; it is also relatively greater in comparison with the neck of the scapula than in the Elephant" (p. 298). The specimen was thus differentiated, in 1845, from all known Mammals of corresponding or approximate bulk, and is now seen to conform in the particulars cited with the bladebone of *Diprotodon*.

A portion of the glenoid cavity and neck of the scapula of a large Mammalian quadruped (no. 1472), from the same Australian deposits, shows similar dimensions to those in the entire scapula of *Diprotodon australis*.

§ 7. *Humerus.*—In *Macropus* the articular head of the humerus is subhemispherical, looks a little backward as well as upward (the bone being held vertically), and overhangs the back part of the shaft. The inner and outer tuberosities rise above the head, in front of it. The inner tuberosity is thicker and shorter than the outer one, which extends ridge-like obliquely from without inward and forward where that end projects, forming the outside of the deep groove, dividing it from the inner tuberosity; the groove expands and shallows as it descends, and is soon lost in the fore part of the shaft.

The inner tuberosity is supported on a columnar development of the fore and inner part of the shaft. From the fore end of the oblong outer tuberosity the "deltoid" ridge extends halfway down the middle of the fore part of the shaft, being more or less prominent in different species. In all the ridge attains its greatest breadth and prominence at its lower part before its sudden subsidence. At the outer side of the shaft above the developed termination of the deltoid ridge, projects a short, thick, longitudinal ridge, with a rough obtuse surface. Thus the fore part of the upper half of the humerus is divided into two facets, the inner one deepening upwards to the inter-tuberous or bicipital groove; the outer one broader and flatter, between the outer and the deltoid ridges. The back part of the upper half of the humerus is also, but less definitely, divided into two longitudinal tracts; the outer one flattened or slightly concave transversely where bounded by the outer ridge; the inner one gradually contracting, with increased transverse convexity, to be continued into the ridge leading to the ento-condyloid tuberosity. The shaft of the humerus is more bent, with the concavity backward, than usual; the distal end not being turned forward in the degree which gives the ordinary sigmoid shape to this bone in unguiculate mammals.

The humerus in Marsupials is not described in either editions (1805, 1835) of the 'Leçons d'Anatomie Comparée.' But in the 'Ossemens Fossiles' (4to, tom. iv. p. 284) CUVIER notes the precaution requisite in the examination of the distal articular surface of the humerus in Marsupials on account of its resemblance to that in *Carnivora*. In the posthumous 8vo edition of the 'Ossemens Fossiles,' tom. vii. p. 276, after the generalization as to the perforation of the inner condyle in *Carnivora*, is added: "ainsi que chez les Didelphes et dans tous les animaux à bourse." So likewise DE BLAINVILLE states that the inner condyle of the humerus is perforated, "chez tous les Didelphes sans exception," using the term in his peculiar taxonomic sense as equivalent to the *Marsupialia* of other zoologists. I have, however, pointed out exceptions to this rule in certain Dasyures (*Dasyurus Maugei*), Phalangers (*Ph. Cookei*), and Petaurists*.

So much it seemed requisite to premise, because the imperforate condition of the inner condyle also characterizes the bone in *Diprotodon*, differentiating it from the humerus in *Macropus* and *Phascolomys*, without, however, affecting the marsupiality of the great extinct Herbivore. To the description of this bone in *Diprotodon* I now proceed.

The humerus (Plate XLVI.) is more nearly straight than in other Marsupials, and is remarkable for the feeble development of the ridges for muscular attachments. At a glance one sees its relations to the restricted offices of support and locomotion with much less subserviency than in the smaller existing Marsupials to more varied applications of the fore limb.

The head of the bone (ib. figs. 1 & 2, *a*, and fig. 3) rises above the tuberosities (*b, c*), forming a very large proportion of the upper end (fig. 3). It has the usual degree of convexity, with a full oval contour, the long axis being transverse, and the smaller end next the outer tuberosity; it overhangs the back part of the shaft at its inner two-thirds (fig. 1), but in a less degree than in the Kangaroo. The inner tuberosity (*b*) is represented by a low broad, rough ridge, extending from the inner side along the fore part of the periphery of the head to near the small outer end of the articular ball; here it is interrupted by a wide but very shallow representative of the "bicipital groove." The outer tuberosity (*c*) projects in a greater degree from the outer side of the base of the head.

The broad, low, rounded angle between the fore and outer sides of the humeral shaft, continued from the fore end of the outer tuberosity (fig. 2, *c*), representing at first the outer side of the bicipital groove, descends and assumes rather more of the character of a muscular ridge at the mid length of the shaft (fig. 2, *d*) before subsiding.

The homologue (ib. *e*) of the short external ridge in *Macropus* here projects as strongly from that side of the bone, but on the same transverse parallel with the lower, best developed part of the deltoid ridge (*d*). Consequently the external ridge is relatively lower placed than in the Kangaroos; it is also relatively shorter, lengthwise, and stands out more abruptly at its upper part.

The representative of the deltoid ridge divides the fore part of the shaft unequally, and the broader division or tract (fig. 2, *f*) is internal, the narrower division or tract (*ib. g*)

* Osteology of Marsupialia, *loc. cit.* p. 400.

being turned so as to form rather the outer facet or side of the upper half of the humeral shaft. Another peculiarity of the present humerus is a well-defined oval rough surface (fig. 1, *h*) at the outer side of the back part of the shaft, one-fourth of the way down; this surface measures 2 inches 2 lines lengthwise, by 1 inch 2 lines across; the lower half of its periphery is most prominent. A low ridge, about an inch in length, in *Macropus major*, seems to answer to this process.

The shaft expands transversely and becomes flattened from before backward at its lower third as far as the distal articulation (fig. 4), which resumes antero-posterior thickness with reduction of transverse extent. The ento-condylar ridge (*i*) is much produced, though relatively less than in *Macropus*; the upper and lower borders meet at an open angle; the ridge is very thick; it extends more than 2 inches from the ulnar condyle; it is imperforate.

The ectocondylar ridge (*k*) is longer than the inner one (*i*), but is less prominent; it is also angular in form, but more openly so. The upper and longer side, commencing 6 inches above the radial condyle, is narrow and slightly turned forward; the lower side rapidly expands to nearly the fore-and-aft breadth of the radial condyle, along the radial or outer border of which the ectocondylar ridge subsides. The middle of the distal expansion of the shaft, above the articulation, is remarkable for the size and depth of the anterior fossa (fig. 2, *l*); the posterior or olecranal depression (fig. 1, *m*) is comparatively feebly marked.

The radial (*n*) and ulnar (*o*) condyles are more convex and more equal than in *Macropus*; they are divided by a narrower and deeper trochlear channel.

The radial condyle is the longest; its outer and hinder marginal contour describes part of a circle, and is not encroached upon, as in *Macropus*, by the rough surface from the ectocondylar tuberosity. The ulnar condyle, which begins in *Macropus* to subside or give way to augment the intermediate concavity, here retains its hemispheroid form (ib. fig. 4, *o*). It is interesting to note this resemblance to the distal articulation of a femur in the humerus of an animal low in the Mammalian scale.

The hind or " olecranal," supracondylar depression (fig. 1, *m*) is shallow, limited in situation to above the ulnar condyle, and the narrow intercondylar channel, and not extending to above the radial condyle.

I have not been able to find the orifice of a medullary artery: the distal portion of the left humerus, broken from the rest of the bone near the middle of the shaft, 11½ inches from the distal end, shows a depression near the middle of the fractured surface half an inch across and not quite an inch deep; and this, if it be not an accidental excavation in the dense cancellous structure, is the sole indication of a medullary cavity. Such cavity is wanting or small in the gigantic extinct Sloths. It is, again, with interest that I view this sign of low organization in the great extinct Marsupial mammal[*].

Ulna.—Of the ulna I have hitherto received only the proximal half, and with the

[*] Description of the Skeleton of *Mylodon robustus*, 4to, 1842, p. 82. Memoir on the Megatherium, 4to, 1860, p. 49.

olecranon not quite entire; it is a strong but low trihedral process, smooth and concave on the inner side, roughish and flattened behind; with a smooth almost horizontal triangular surface at the upper part. The breadth of the base of the olecranon is 3 inches 10 lines; the circumference of the base is 13 inches. The articular surface answering to the " greater sigmoid cavity" is concave, longer and deeper from before backward than from side to side. From its upper and outer part a less concave articular surface is continued upon the inner side of the base of the olecranon. The lower part of this surface, which may have afforded the " lesser sigmoid cavity" to the radius, is broken away. The rough tract for syndesmotic junction with the radius extends down the outer side of the shaft inclining obliquely forward: it is about an inch in breadth. There is a small but well-marked tuberosity and depression, on the outer or radial side of the ulna, $1\frac{1}{2}$ inch below the " greater sigmoid cavity," answering to a corresponding process in the Wombat. The elongation of the olecranon in that burrowing Marsupial, augmenting the lever for working the fore paw, does not exist, and was not needed in the gigantic gradatorial *Diprotodon*. The portion of ulna above described indicates a massive and powerful fore arm, and has encouraged me to indicate the continuation of the ulna, as a distinct bone, to the carpus, in my restoration of *Diprotodon* (Plate L.). The canal for the medullary artery enters the bone on the inner side (that next the radius) below the " sigmoid" articular cavity, and the canal is directed inward and a little upward. This fossil was obtained in the bed of the Condamine River, west of Moreton Bay, by Sir THOMAS MITCHELL, C.B.

§ 8. *Pelvis.*—In a collection of bones from fluviatile freshwater deposits at Eton Vale, Darling Downs*, in the usual massive or weighty, semipetrified condition of fossils from those beds, were fragments of a large pelvis, readjustible to the extent of giving a great part of the sacrum and ilia, both acetabula, the acetabular portion of each ischium to the extent of 7 or 8 inches, and about 5 inches of the acetabular end of each pubis.

The sacrum consists of two vertebræ (Plate XLVII. s_1, s_2), uniting with the ilia (ib. $_{62}$) by a terminal expanse of the transverse processes (ib. fig. 1, pl_1, pl_2), coequal with the antero-posterior extent of the entire sacrum, and giving to that bone a subquadrate form one-third broader than it is long. Much of the anterior articular surface of the body of the first sacral (fig. 1, s_1) is preserved, and a smaller proportion of the posterior surface of that of the second sacral (ib. s_2). Both surfaces show the usual mammalian flatness and concentric lineation for union by intervertebral sclerous substance with contiguous centrums: the rougher surface shows the loss of the epiphysial plate. The transverse diameter of the fore part of the first centrum is 5 inches; the vertical (neurohæmal) diameter is 3 inches. The transverse diameter of the hind end of this centrum, giving that of the fore end of the succeeding anchylosed centrum (s_2), is 3 inches 5 lines. The hæmal† surface of both centrums (Plate XLVII. fig. 1, s_1, $_2$) is flat, subquadrate, the

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* These fossils, collected in the above-named locality by EDWARD S. HILL, Esq., were liberally presented to the British Museum by Sir DANIEL COOPER, Bart., in 1864.

† In noting the position and aspect of the parts of this pelvis according to anthropotomical description,

contour being straight lengthwise, the coalesced ends making no projection forward or hæmad.

The upper and anterior border of the first centrum, however, is abraded, as is the lower and anterior border of the second centrum ; both being entire, would give a slight concavity to the longitudinal contour of the hæmal surface.   The length of the sacrum is 5 inches 8 lines, that of the anterior centrum being 3 inches 3 lines.   The rib-part (pl 1) of the broad and thick transverse process of the first sacral recedes slightly as it expands, passing outward to join the ilium (62), with a slight curvature convex hæmad. The greater part of the hæmal surface of the process is flat transversely, becoming slightly concave at its hind part; lengthwise it is here convex from before backward. The line of the confluence with the ilium, indicated by a slight eminence (ib. fig. 1, p, p), is feebly curved with the convexity outward.   The sacro-iliac symphysis is 8 inches in length following the curve; the origin of the sacral rib or transverse process has a fore-and-aft extent of 3 inches 9 lines.   The direction of the origin of the process in both vertebræ is oblique, from near the neural surface of the centrum anteriorly to the hæmal one posteriorly.   The hind border of the origin of the first transverse process forms the fore margin of the wide anterior outlet of the intervertebral canal (i), which expands into an infundibuliform channel backed by the succeeding transverse process (pl 2).

The neural position of the fore part of the transverse process (pl 2) of the second sacral makes the aspect of the nerve-outlet (i) obliquely hæmad and backward; the long diameter of the outlet is $1\frac{1}{4}$ inch; the mass of nerves therefrom emerging has deeply grooved the upper or fore part of the great sciatic, or sacro-ischiatic notch (m). The outlet thus intervening between the bases of the transverse processes is circumscribed externally by the confluence of the expanded ends of those processes, forming the articular surface of the sacrum with the ilium.

The tuberosity (Plate XLVII. figs. 2, 3, z') representing the confluent zygapophyses of the first and second sacrals is on the inner side and anterior to the posterior outlet (ib. fig. 2, j) of the intervertebral nerve-canal, and partly overhangs a smaller outlet (g) of a canal passing backward to open into the large intervertebral canal.   The fractured base of the left postzygapophysis (ib. z'') of the second sacral is preserved, close to the outer end of the hind margin of the neural arch.

The neural spine of the first sacral (ib. figs. 2 & 3, ns 1) is coextensive at its base with the summit of the arch, has a fore-and-aft extent of 2 inches, a transverse breadth of 1 inch 2 lines.   The summit of the spine is broken away at the height of about 1 inch,

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the surface of the sacrum and ilium turned toward the pelvic cavity is " anterior" or " forward;" but in the ordinary posture of the quadruped it would be " inferior" or " downward."   In the nomenclature of Dr. BARCLAY such surface would be " central" and look " centrad," the opposite surface " peripheral" and looking " peripherad;" or those surfaces might be " sternal" and " dorsal" respectively.   I shall use the term " neural" and " neurad" in the sense of BARCLAY's " dorsal" and " dorsad" and of the anthropotomist's " posterior," and the term " hæmal" and " hæmad" in the sense of " sternal" and " sternad."   Fore or anterior, and aft, hind, or posterior will be used to denote the relations of the parts toward the head or the tail of the quadruped.

and there the spine is 1 inch in thickness and 1 inch 7 lines in fore-and-aft extent. The anterior orifice of the neural canal (Plate XLVII. fig. 3, *n*) is 3 inches 5 lines in transverse diameter, but only 1 inch vertically between the centrum and summit of the neural arch; and this dimension is rather lessened at the middle of the canal by a slight rising along that part of the neural surface of the centrum. A medial vertical ridge with a depression on each side marks the fore part of the base of the thick neural spine (*ns* 1,): The fractured base of the prezygapophysis (*z*) of the first sacral measures 2 inches 4 lines by 1 inch 5 lines.

A partial ossification extends from the base of the neural spine of the first to that of the second sacral (ib. fig. 2, *ns* 1 & 2), bisecting a deep triangular depression, which, however, does not communicate with the neural canal; a continuous ossification from the first to the second sacral neural arch forms a smooth unbroken ceiling to the canal. The posterior outlet of the neural canal (ib. *n'*) of the second sacral is transversely extended, 3 inches 6 lines across, 10 lines in height on each side the mid rising of the centrum. A greater proportion of the neural spine (*ns* 2) of the second sacral than of the first is broken away; the remaining base gives 1 inch 8 lines in fore-and-aft extent, 10 lines in greatest breadth, which is at the hind part; the fore part is ridged with a small depression on each side. The irregular ossification is continued from the median ridge to the antecedent spine.

Of both ilia a large proportion has been preserved. The acetabular part (*o*) swells out from the body of the bone, before (fig. 1) and behind (fig. 2), and developes a tuberosity (*d*) oblong lengthwise, triangular transversely, at the upper or anterior part of the brim of the cavity. In advance of the acetabulum the ilium contracts, especially from the neural to the hæmal aspect, or is depressed and lamelliform; but continues thickest medially to form the junction with the sacrum, and contracts laterally to a smoothly rounded concave margin (ib. figs. 1 & 2, *n*). About the sacro-iliac symphysis the medial and anterior border, or "crista" of the ilium (*c*) contracts to a thickness of $1\frac{1}{2}$ inch, and where it is entire is convex and roughened. At the fore part of this symphysis is an oval foramen, 1 inch by 9 lines in diameters (ib. fig. 3, *f*), the outlet of a canal communicating with the capacious intervertebral canal. The free portion of the ilium is lamelliform, arches outwardly, the thin outer or hinder border (*n*) describing a bold concave curve. Save for two inches near the symphysis of the right ilium, the crista is broken away. The hæmal surface of the iliac plate (fig. 1, 62) is almost flat. Transversely, it is convex one-third of the extent from the fractured margin (*c*), concave to the opposite outer margin (*a, n*), both curves being feeble; lengthwise it becomes concave toward the acetabulum. The hæmal tract (*p, p*) of the sacro-iliac symphysis forms a low broad smooth convex ridge, enlarging and slightly rising as it approaches the acetabular part of the ilium, but subsiding before this begins to expand; this ridge, or tract, feebly represents the "linea ileo-pectinalis." It seems to be suddenly resumed by a process (*e*) at the junction of the ilium with the acetabular end of the pubis (64). I infer, at least from its being broken off on each side of this pelvis, that it projected far enough to be called

a " process" rather than a " tuberosity."   The fractured base is oblong, $1\frac{1}{2}$ inch by 9 lines. The process so indicated answers to that called " ilio-pubic" in *Poëphaga**.

The neural surface (Plate XLVII. fig. 2, 62) of the free part of the ilium is almost as flat as the hæmal surface; lengthwise the general slight convexity changes to a concavity as it approaches the acetabulum; transversely the surface becomes gently convex towards the thin concave border (*n*).

The neural surface of the ilium is divided into a rough and a smooth part; the latter is exterior, narrow, extending about $1\frac{1}{2}$ inch from the external border (*n*), becoming gradually narrower to within 4 inches of the precotylar tuberosity (*d*), where the smooth tract ends; the rest of the neural surface of the iliac plate is chiefly roughened by coarse grooves and low ridges, mostly inclining lengthwise with more or less obliquity, indicative of coarse and strong muscular attachments.

At the inner and back part of the sacro-iliac symphysis an angular tuberosity, answering to the " posterior inferior spine," unites with a larger rough tuberosity from the transverse process of the second sacral vertebra, together forming a large " sacro-iliac " tuberosity (ib. *u*), overhanging the deep and wide groove at the fore or upper part of the great sacro-sciatic notch (*m*).   The plane of the long curved lamelliform ilium is thus almost horizontal, or with surfaces looking neurad and hæmad; the long axis of the bone forms with that of the sacrum an angle of 35° (Plate L. 62, *s*).

Of the ischium (ib. figs. 1, 2, 4, 63) the spine is represented by a slightly prominent surface (*l*), roughened at its upper and lower margins, of an oval form, 2 inches by 1 inch in diameters, the long one being in the direction or axis of the ischium, and the small end of the oval is forward.   Between the upper part of the "spina ischii" and the neural margin of the acetabulum is a low subcircular rugous tuberosity (fig. 2, *q*) 1 inch in diameter.   The back or neural wall of the acetabulum contracts as it retrogrades, the part contributed by the ilium being broader than that by the ischium.

The acetabular part of the innominatum contracts transversely, and expands in the neuro-hæmal direction from the line *m*, *d* to the line *l*, *t*.

The ischium as it is produced backward beyond the acetabulum contracts, but is rounded and thick posteriorly, and is thinned off only anteriorly where it forms part of the margin of the " foramen ovale."   The ischia diverge from each other at this part, instead of retrograding parallel with each other as in *Macropus*; but to what extent is not shown in the present specimen.

The great sacro-sciatic notch (figs. 1 & 2, *m*, *l*) presents a deep and wide groove (*m*) at the fore part, overhung by the produced hind part of the sacro-iliac symphysis (*u*), which symphysis is here obliterated by anchylosis.   Below the groove the back part of the acetabulum makes convex that part of the margin of the notch, which margin is again concave slightly to the tuberosity representing the ischial spine (*l*).

* Osteol. of Marsupialia, *tom. cit.* p. 403: the shares taken respectively by the ilium and pubis in the formation of the ilio-pubic process is shown in the ' Cy lopædia of Anatomy,' 8vo, vol. iii. (1841), Art. *Marsupialia*, p. 284, fig. 110 (*Hypsiprymnus*).

In both "innominata" the pubis (64) is broken off close to the acetabulum. The diameters of the fractured surface are 2 inches 6 lines and 1 inch 5 lines, the latter breadth being near the back part of the bone which gives a subtriangular section. The anterior apex is formed by a rough ridge, which rises from the hæmal part of the pubis about 2 inches from the ilio-pubic process (Plate XLVII. fig. 1, e), leaving a shallow groove between the ridge and the acetabular margin.

The acetabulum (ib. fig. 4, t) is a nearly hemispherical depression, $5\frac{1}{2}$ inches by $5\frac{1}{4}$ inches across the opening, nearly 3 inches in depth; its rim is smoothly rounded and less thick between the pubic ridge (64) and the "antero-inferior" iliac spine (d); thicker and rough from this to the posterior or ischial part (63'); this, as it bounds the acetabulum posteriorly, curves upward, gradually subsiding to form the outer wall of the "cotyloid notch" or groove (y) conducting the vessels to the synovial and adipose mass about the expanded, rough, slightly depressed surface for the origin of the "ligamentum teres." This surface (x) is oval, 2 inches 8 lines by 1 inch 3 lines in diameters; the cotyloid groove is 10 lines wide. The aspect of the acetabulum is outward and more obliquely downward and backward than in *Macropus*, through a greater development of the iliac, and especially of the pubic, walls.

The sacrum is in the line of the lumbar vertebræ, upon which line the ilia are directed obliquely forward and neurad at the angle above given (Plate L.).

The condition already noted of the materials for the recomposition of the present pelvis allows not of determination of the form and extent of the "brim of the pelvis," assuming, as is most probable, that this was naturally entire; nor does it give the extent, form, and direction of the ischio-pubic symphysis which I conclude to have existed. The transverse diameter of the pelvic cavity between the acetabular origins of the pubic bones (ib. fig. 1, 64) is 1 foot, between the ischial spines (l, l) 7 inches. From the portion traceable of the "foramen ovale" I infer it to have been relatively large, as restored in Plate L.

The ischia are divergent in the extent to which they are preserved. Although the tuberosity and terminal part of the ischium are wanting, the hinder articular surface of the second sacral centrum (Plate XLVII. fig. 2, s 2) permits a conclusion that the ischia were free from any direct union with the vertebral column.

The remains of no quadruped so large as that indicated by the above-described pelvis, save those of *Diprotodon*, have been discovered in the freshwater deposits of Darling Downs. Yet it would betray an undue confidence in the proportion of present acquisitions of fossil remains to the entire extinct mammalian population of Australia, to infer specific relationship from sameness of locality, or even some degree of juxtaposition of parts of a skeleton. It is incumbent, therefore, to state the results of the comparison of the pelvis in question with those of known genera of Mammals which have led me to the conclusion that it is marsupial and referable to the largest known species of the pouched order.

The most conspicuous feature of the pelvis, without doubt, is unlike the corresponding part in any known marsupial, and so much more resembles that in the Elephant as to

have supported the view first suggested by the flattened form of the femur next to be described, if more instructive characters had not been shown deducible from the pelvis in question.

The ilia, though not quite entire along the "labrum" (Plate XLVII. figs. 1 & 2, *c*), are sufficiently so to support the inference that they were short, broad or expanded, with a flattened surface rather than a fossa, directed hæmad or downward, and in a minor degree forward. Such a lamelliform ilium is not presented by any existing genus of Marsupial, but is found, besides the Proboscidians, in Megatherioids, Sloths, Apes, and Man.

From the Elephant's the ilia of the present species differ in the much less production of the angle terminating in the antero-superior spine (*a*, *a*), which, in Proboscidians, extends outward and bends down in an almost hooked form to near the parallel of the acetabular outlet.

In the Megatherium and Mylodon the ilia are proportionally more expanded and outwardly extended than in the Elephant. The ilia of the Sloths (*Bradypus, Cholœpus*) come nearer to the proportions of those in Plates XLVII.; but the antero-superior angle is rounded off, and the position and aspect of the iliac planes are different. There is, however, a more marked, definite, and weightier distinction between the present pelvis and that of other Mammals with expanded lamelliform ilia. Leaving the human and simial pelves out of the comparison, that of the Elephant includes four sacral vertebræ, and the Sloths, both arboreal and terrestrial, have the sacrum unusually prolonged to effect the second junction with the innominate bones at the ischial tuberosities, thus converting the "great sciatic notch" into a foramen.

In the present pelvis the sacral vertebræ are but two in number. Now this, as a rule, is the number to which the sacral vertebræ are restricted in *Marsupialia*; and it strikes me as the more significant of the affinity, so indicated in the present pelvis, because it is associated with a modification of the ilium which, in the placental series, goes with at least double that number, and commonly with many more sacral vertebræ, five or six, *e. g.*, in the Sloths and Megatherium, and as many as eleven vertebræ anchylosed in a mass in the Mylodon. A still more decisive mark of Marsupial affinity in the pelvis in question is the evidence of an ilio-pubic process (Plate XLVII. fig. 1, *e*, *e*); and this also points to the particular family of *Marsupialia* to which the large quadruped under consideration is more nearly related. Only in the Kangaroos is this process so developed as to be subject to such violence as has broken it away on both sides of the present pelvis. In all other *Marsupialia* it is indicated, if at all, by a mere tuberosity. The concurrence, therefore, of a bisegmental sacrum with the ilio-pubic process decides me to restrict further comparison with the pelvis of the Kangaroos (*Macropus*).

I take the difference of form of the iliac bones, which is very great, between *Macropus* and *Diprotodon*—for if we arrive at the Marsupial genus with a diprotodont dental formula by the pelvic route we may be absolved of rashness in drawing the obvious conclusion—to depend on the corresponding differences in the mode of locomotion deducible

from the structure and proportions of the limb bones. *Diprotodon*, by the equable and massive development of fore and hind limbs, must have progressed on dry land, like the Elephants and Megatherioids, with a regular, quadrupedal, gravigrade pace, though no doubt less sluggishly than either *Mylodon* or *Megatherium*. It is evident that it could not depend on the hind limbs alone for rapid escape from enemies as do the Kangaroos. The powerful exertions those singular marsupial animals impose upon their long legs in the successive bounds by which they rapidly traverse the plain, call for the provision of long muscles and of strongly contracting ones, indicated by the long, strong, three-sided, and three-ridged ilia, in which both sides of the prism destined for muscular attachments are deeply hollowed. The corresponding pelvic muscles in *Diprotodon* must have been relatively shorter, less thick, but broader, and, in relation to the thigh bone, arranged and disposed more or less as in the Elephant.

Amongst minor differences between *Macropus* and *Diprotodon* in the anatomy of a part of the skeleton in which they agree in more essential characters, I note that the outer margin of the sacral apophyses (Plate XLVII. fig. 1, *pl* 1, *pl* 2), uniting with the ilia at *p, p*, do not curve hæmad as in *Macropus*, making that surface transversely concave.

The outlet of the anterior canal communicating with the wide intervertebral nerve-passage, answering to that marked *g* in *Diprotodon* (ib. fig. 2), is relatively smaller and more in advance of the soldered zygapophyses uniting together the two sacrals in *Macropus*. The " spine of the ilium " in *Macropus* is represented by a relatively narrower and less prominent surface than in *Diprotodon*, is further from the ischial spine, nearer the middle of the back wall of the acetabulum in *Macropus*. The breadth of this wall is almost equal in the Great Kangaroo, and the hind contour of the acetabular brim is almost parallel with the coextensive inner and hinder border of the innominatum.

The ischium, as it is produced backward beyond the acetabulum, is relatively more compressed and lamelliform in *Macropus* than in *Diprotodon*, and, most probably, is relatively longer. In the acetabulum itself the vascular groove and the ligamentous depression are relatively deeper in *Macropus* than in *Diprotodon*.

§ 9. *Femur.*—The femur is remarkable for the length, breadth, and depth of the proximal end, including the " head," " neck," and " trochanters," for the rise of the head above the great trochanter, for the fore-and-aft flattening of the shaft, and for the extent in the same direction of the inner condyle chiefly due to the prominence of its narrow anterior tuberous end.

The chief dimensions of this bone are given in the 'Table of Admeasurements,' p. 574.

The " head " (Plates XLVIII. & XLIX. fig. 1, *a*) is egg-shaped, the great end hemispherical with the articular surface produced upon the upper part of the neck, contracting and representing the small end of the egg (Plate XLVIII. fig. 1, *b*). There is no pit for attachment of a ligamentum teres ; the sole indication of any special addition to the fibres of the capsule of the joint is a rough shallow indent of an angular form, encroaching on the ball from the under part of its periphery (Plate XLIX. fig. 1, *c*). The fore-and-aft diameter of the head is $4\frac{1}{2}$ inches ; the transverse extent to the end of the supracervical

apex is 6 inches: this production is more conspicuous at the fore (Plate XLVIII. fig. 1, *b*) than at the back part (Plate XLIX. fig. 1). The margin of the articular surface is slightly prominent, through the sudden contraction of the rough surface of the neck; but this is chiefly at the fore part (Plate XLVIII. fig. 1, *d*), towards which aspect the head slightly inclines. At the back part of the neck, just beyond the head, there is a low ridge 1½ inch long (Plate XLIX. fig. 1, *e*) parallel to the margin of the articular surface.

The rugged surface of the great trochanter commences at the middle of the upper part of the neck, with a moderate elevation and a border convex towards the head (Plate XLVIII. fig. 2, *f*); its fore-and-aft breadth here is 3½ inches, but the process expands as it recedes from the head, sloping downward to a breadth of 4 inches 10 lines; its outer expanded termination is subbilobed, the posterior lobe (ib. *h*) being most produced outward; the anterior one (ib. *g*) is continued furthest down the shaft.

Anteriorly the great trochanter is defined by the abrupt rising of the rugged surface from the smooth surface of the neck along a curved line (ib. fig. 1, *i, i*), which bends round the lower part of the anterior lobe (ib. fig. 1, *g*),: this is continued upon the fore part of the shaft near its outer margin for an extent of 5 inches from the upper surface of the lobe; the posterior lobe (Plate XLIX. fig. 1, *h*) extends a shorter way down the outer surface of the femur, and is defined, or rises, very abruptly from the smooth tract of that part of the shaft. The posterior part of the trochanter projects as a thick oblong tuberosity (ib. fig. 1, *k*) above the trochanterian depression (ib. *l*): the mouth of this depression is 3 inches 8 lines in length, 1 inch in breadth, opening parallel with the lower margin of the neck, and is 3 inches in depth. Beyond the depression the posterior margin of the trochanter is less defined from the femoral shaft than is the anterior one. The neck of the femur (Plates XLVIII. & XLIX. *m*) begins by hardly a less diameter than the head from above downward, and augments in that direction as it extends outward; it is rapidly compressed from before backward, as it recedes, especially where it is continued into the trochanterian fossa (*l*); its upper margin is slightly concave from within outward, convex from before backward, 2 inches broad in that direction; the lower margin is 2 inches 6 lines. This margin is not uniformly convex across, but is remarkable for the production of its hinder half into a long narrow elliptical rough ridge, representing the small trochanter, which is 6 inches in length and 1½ inch across the middle (Plate XLVIII. fig. 1, *n*).

The lower ends of this and of the anterior tuberosity of the great trochanter are on the same transverse parallel, at which the proper shaft of the femur may be said to commence. This is defined by a gentle concave curve in both outer and inner sides, the least transverse diameter being 4 inches 5 lines. At the upper half of the shaft the fore-and-aft thickness decreases from the outer to the inner border, which is reduced to 2 inches before rounding off. This border gains in thickness as it approaches the lower end.

The outer side of the compressed shaft preserves a thickness of about 2½ inches along

its middle two-thirds, expanding above and below to the ends of the bone. The fore surface of the shaft is smooth, the hind surface shows a shallow narrow longitudinal depression (Plate XLVIII. fig. 2, o; Plate XLIX. fig. 1, o), and near the outer border, $3\frac{1}{2}$ inches above the outer condyle, it is $2\frac{1}{2}$ inches in length. A subcircular feebly marked rough surface or patch (Plate XLIX. fig. 1, p) is discernible near the middle of the back surface, not quite halfway down the shaft.

The rotular surface (Plate XLVIII. figs. 1, 2, 4, r) of the distal end, defined by a low rising from a slightly depressed fore part of the lower end of the shaft (ib. fig. 1, q), is made strongly concave transversely by the forward production of the narrow tuberous end (ib. s) of the fore part of the inner condyle (t), from which it is divided by a channel $\frac{1}{2}$ an inch wide (ib. fig. 4, x) continued to the intercondylar pit (u) from the inner surface of the distal end of the shaft. The large rotular surface, thus concave transversely, convex from before backward, is broadly continuous with the articular surface of the outer condyle (ib. figs. 1 & 4, v). The fore-and-aft extent of the inner condyle, including the rotular part, is 8 inches; the same diameter of the outer condyle is but 4 inches 7 lines. The transverse diameter of the back part of the inner condyle is 3 inches 6 lines; that of the outer condyle is the same; the transverse diameter of both condyles (Plate XLIX. fig. 1, t, v), including the intervening depression (u), is 7 inches 6 lines. The form of the articular surface is very different here, in the two condyles; the inner one (t) shows a full convexity in both directions, the transverse contour becoming flattened toward the outer border. The outer condyle (v) is slightly concave transversely along two-thirds of its middle part, the outer convex border being somewhat produced; the outer condyle is also less convex from before backward than the inner one. There can hardly be said to be a popliteal depression; the vertical line of the back of the shaft is continued directly into the intercondyloid groove (u), the sides of which are formed by the production of the back parts of the condyles.

The inner surface of the distal end of the shaft developes a strong ridge (Plate XLVIII. fig. 5, w), extending above 4 inches from the back part of the inner condyle toward the rotular division of the same. The outer supracondylar surface is more even and is slightly concave, divided by a moderate rough prominence (ib. fig. 1, y) from the smooth outer part of the shaft.

The outer side of the shaft, for a short way below the great trochanter, joins the hind surface at an angle, simulating a low ridge continued from the end of the hind lobe of that process, and subsiding into the rounded smooth convexity of the outer part of the shaft; but there is no "linea aspera." I cannot detect in this femur any orifice of a medullary artery. The fractured surface of the shaft of a left femur does not indicate any medullary cavity. But in the shaft of another femur, corresponding with the above in size and shape, the transverse being to the antero-posterior diameter as two to one, there is a conspicuous orifice for the medullary artery, at the back part and a little above the middle of the shaft, toward the inner side; the canal slopes upward, to a small spheroid medullary cavity, with dense walls 1 inch in thickness (Plate XLVIII. fig. 3).

The femur, like the pelvis, of *Diprotodon* presents the greatest resemblance in general form and characters to the corresponding bone in *Proboscidia*. The head is devoid of the ligamentous pit; the shaft is straight and antero-posteriorly compressed; there is little* or no medullary cavity.

Passing to particulars of structure, there appear several more or less well-marked differences.

The head rises higher above the neck and trochanter in *Elephas*; it has a more directly upward aspect, the neck is shorter, the great trochanter is absolutely, as well as relatively, of less extent in *Elephas*. The trochanterian depression is less deep, and opens nearer the exterior surface of the trochanter. A ridge is continued downward from the border of the depression, which, with a second ridge continued downward from the outer part of the trochanter, bounds a flat facet forming the outer surface of the upper half of the shaft: there is no such definite facet in *Diprotodon*. At the upper and fore part of the trochanter in *Elephas* there projects a tuberosity midway between the head of the femur and the outer part of the trochanter, and the neck rising to support this tuberosity is somewhat convex transversely: there is no trace of this tuberosity in *Diprotodon*, and the fore part of the neck is concave transversely. The small trochanter, which in *Elephas*, as in *Diprotodon*, is a long longitudinal ridge, is situated lower down in *Proboscidia*. The ridges continued from the great trochanter upon the shaft represent, in that order, "lineæ asperæ," of which there is no trace in *Diprotodon*.

The differences become more marked at the lower end of the bone. The rotular surface or pulley is absolutely as well as relatively narrower in *Elephas*; it has a more anterior aspect, is supported on an anterior production or expanse of the femur; the sides of the pulley are parallel, subequally developed; there is no production of the inner one as in *Diprotodon*. The outer as well as the inner part of the rotular articular surface is distinct from that surface in the corresponding condyle. Both condyles are convex and equally prominent behind in *Elephas*; in which genus there is no transverse hollowing of the outer condyle, giving a trochlear character with production of the outer border of that condyle as in *Diprotodon*. The intercondylar groove is deeper and narrower in *Elephas* than in *Diprotodon*.

Omitting the notes of comparisons of the femur of *Diprotodon* with that in other large quadrupeds, the essential correspondence throwing true light on the determination of the species to which it belongs, and the affinity of that species, is found in the *Poëphaga* or *Macropodidæ* exclusively. It is there only that one finds the transverse excavation of the surface of the outer femoral condyle, producing the contrast of a trochlear character of surface with the uniform convexity or ball-like prominence of the inner condyle. In the Great Kangaroos (*Macropus major*, *M. laniger*) the character is exaggerated, the channel is deeper, and its outer border is more produced. The rotular surface is broad, with unsymmetrical sides in *Macropus*, the inner border being sharpest, though less produced anteriorly than in *Diprotodon*.

* See Osteological Catalogue of the Museum of the Royal College of Surgeons, 4to, p. 481.

Macropus further agrees with *Diprotodon* and differs from *Elephas* in the continuity of the articular surface, giving that of the synovial cavity, of the rotular and condylar joints; but in *Macropus* the inner as well as the outer condyle is so continuous. The intercondylar groove is relatively wider in *Macropus* than in *Diprotodon*, and, the condyles being more backwardly produced, it is deeper. The longitudinal ridge-like small trochanter is placed higher in *Macropus* as in *Diprotodon* than it is in *Elephas*. The attachment of that muscle, which leaves a circular rough patch at the back of the femoral shaft in *Diprotodon*, is developed into a tuberosity in *Macropus*. The trochanterian depression is very deep in *Macropus* as it is in *Diprotodon*. The great trochanter is bilobed exteriorly in *Macropus*, but with a deeper and differently directed dividing channel than in *Diprotodon*.

I discern in the foregoing correspondences the essential marks of affinity, and view the greater elevation of the trochanter major in *Macropus*, the greater length and cylindroid form of the shaft of the femur, the greater relative antero-posterior extent of the distal end, and especially of the outer condyle, with the stronger indications of muscular attachment, as adaptive characters in the smaller Marsupial related to its more rapid and vigorous modes of locomotion.

§ 10. *Tibia.*—The tibia, of the general dimensions given in the Table of Admeasurements, p. 574. I conclude, by the agreement in size and character of the upper articular surface (Plate XLIX. fig. 4) with the lower one of the femur (Plate XLVIII. fig. 4), to belong to the same leg, viz. the right one, of *Diprotodon*.

The external upper articular surface (Plate XLIX. figs. 3 & 4, *a*) is gently undulated, with a transverse convexity adapted to the corresponding concavity on the outer femoral condyle, and with the concavities, though slight, answering to the convexities of that condyle. The inner articular surface (ib. fig. 4, *b*) is larger, and presents a uniform concavity to the convex inner femoral condyle. The ridge or spine (ib. figs. 2, 4, *c*) between the articular surfaces extends 2 inches from behind forward and a little outward; it is from 6 lines to 10 lines thick, and is roughly excavated above. The rough part of the upper surface of the tibia (ib. *d*), in advance of the articulations, is more extended transversely from behind forward. The breadth of the upper surface exceeds by two-fifths the fore-and-aft diameter. The articular surface for the head of the fibula (ib. fig. 3, *e*) is continuous with the outer articular surface (*a*), and extends from its outer and hinder margin at a rather acute angle or nearly a right angle, 1 inch 4 lines down the shaft, the breadth of the surface being 1 inch 6 lines. In advance of this surface projects the external tuberosity (*f*), from which a thick (epicnemial) ridge-like rising of bone (ib. fig. 2, *g, g*) extends in front of the upper end of the tibia for about 5½ inches. This ridge or prominent tract is longitudinally striate or scratched, as if it were an ossified ligamentous attachment. At the middle of the fore part of the tibial head a narrow ridge (ib. fig. 2, *h*) is continued from the transverse one 2 inches down the shaft, like the procnemial ridge in birds, but much less produced. From the junction of the "epicnemial" ridge with the outer tuberosity a narrow "ectocnemial" ridge (ib. *i*)

extends for an inch or two down the shaft.   Beneath the outer tuberosity is a rough shallow cavity (ib. fig. 3, k), and a similar but smaller one (ib. l) impresses the shaft a little way below the fibular articular surface.   An internal tuberosity (figs. 2 & 4, m) is feebly marked below the contracted inner end of the inner articular surface.

The shaft of the tibia rapidly contracts to a transverse diameter of $2\frac{1}{2}$ inches at the middle third of its extent, where it is trihedral, with the angles rounded off.   It appears to be twisted with the inner malleolus turned forward; but this is very feebly marked, not projecting below the distal articular surface.   At the outer and back part of the lower half of the shaft is a rough longitudinal prominence (fig. 3, n), 4 inches by 1 inch, seemingly for ligamentous attachment of the corresponding part of the shaft of the fibula.   At the inner and back part of the shaft a low narrow fibrous ridge runs parallel with the inner border of the fibular ridge, defining therewith an oblique shallow canal, 9 lines in width.

A slightly raised border of bone (figs. 2, 3, p), from 1 to 2 inches distant from the lower articulation, seems to indicate the original line of junction of the epiphysis. Malleoli cannot be predicated of the distal end of this tibia (ib. fig. 5).   At the inner periphery of the articular surface, instead of a prominence there is a notch (ib. q), from which a groove $1\frac{1}{2}$ inch long and 5 inches wide extends outward and forward into the joint; the rough convex border of the articulation external to this, corresponding in position to the fore part of the upper end of the tibia, appears to represent an internal malleolus. On each side the entering groove (q) the distal articular surface is slightly convex; in the rest of its extent it is nearly flat; its form is oblong, with the long axis at right angles to that of the upper articular surface, $i.\,e.$ from before backward instead of from side to side.

In a portion of the shaft of a tibia, obtained by Sir THOMAS MITCHELL from the bed of the Condamine River, the upper part of the ridge between the outer and hinder surfaces shows the orifice of a medullary arterial canal, which expands as it slightly descends.   No medullary cavity, however, is shown in this fragment.   The compact part of the wall of the shaft is half an inch thick, and a moderately close cancellous structure extends inward to the centre of the shaft.

A subtrihedral portion of bone, including the distal end and accompanying the above portion of tibia, I believe to be part of the fibula; it is 7 inches in circumference. The centre of the shaft is occupied by a close cancellous texture.   The articular extremity is much abraded; a trace of the epiphysial suture remains; and I find that this is long conspicuous in the fibula of the Wombat.   I have given what I conjecture to be the proportions of the fibula in my restoration of the skeleton of *Diprotodon*, Plate L.

In the singular form of the tibia of *Diprotodon* are presented Marsupial characters exclusively.   " The outer articular surface is continuous with that of the head of the fibula "*, as in the Wombat and Koala; " the shaft of the tibia is twisted as in Opossums, Dasyures, Phalangers, and Petaurists, as well as in the Koala and Wombat "*.

..* Osteology of the Marsupialia, *loc. cit* p. 405.

"The internal malleolus is very slightly produced in any Marsupial"*, save in the Wombat and Kangaroo.

"The fibula is complete and forms the external malleolus in all Marsupials;" and such may be inferred to be its condition from the evidences of attachment shown in the tibia of *Diprotodon*. Only, instead of "the close contact and attachment ensuring a due degree of fixity and strength"* in the Kangaroos, I infer from the articular surfaces on the tibia for the fibula and for the foot that this "enjoyed a movement of rotation analogous to the formation and supination of the hand"*, as in all save the saltatory Marsupials; and we may infer a corresponding modification of the foot approximating *Diprotodon* to *Phascolomys*.

§ 11. *Conclusion.*—Thus in the series of *Mammalia* which characterizes the Australian continent we have evidence of the former existence of a species as large as the *Megatherium*—that strange extinct animal which similarly crowns the series of *Bruta* correspondingly characteristic of the South American Continent.

It is interesting to note the similarity in size, number, and form of working-surface of the molar teeth in the extinct Marsupial and Bradypodal giants; so much so that, notwithstanding the different dental structures and conditions of growth, one cannot resist the inference of a correspondence of diet. But whereas in *Megatherium* the front teeth are wanting, and the prehension of the vegetable food was allotted to limbs and tongue, in *Diprotodon* instruments allied to those by which the Beaver and Wombat gnaw the ligneous fibre were magnified to the proportions of the body to be provided for. The Marsupial monster brought down the tempting foliage by erosion of the trunk, not by the strong hawl of a forcible grasp. Accordingly, the limbs show not those abnormal proportions which distinguish the Megatherioids; they manifest, especially the hind ones with the pelvis, in the Diprotodon, forms and proportions recalling those of the Elephant, and suggestive of analogous uses and mode of progression. The fore limbs may be inferred by the modifications of the distal articulation of the humerus, and by what is known of the ulna, to have enjoyed the rotatory as well as flexile movements. Herein the Diprotodon resembles the Megatherium rather than the Elephant; but the truer inference from the retention of the rotatory and probably unguiculate structure of the fore paws is that, as in the existing herbivorous Marsupials, they were needed for the manipulations of the pouch.

The resemblance in the Diprotodont and Megatherioid dentitions, guiding to the recognition of function or adaptive purpose, are underlain, as above hinted, by differences of textural and genetic conditions. *Diprotodon* combines enamel with dentine, osteodentine, and cement; *Megatherium* has no enamel. In *Diprotodon* the molars have a limited period of growth; in *Megatherium* that period was limited only with life.

The Australian giant adds to number, relative size, and shape of crown, of its molars, in which it accords with the existing macropodal marsupial dwarf of that land, the further correspondence in the coronal enamel and the divergent roots of the grinders.

* Osteology of the Marsupialia, *loc. cit.* p. 405.

Similarly, the American phytophagous giant added to a bilophodont working-surface of its few and small molars, the peculiar texture and rootless condition of the long deeply implanted ever-growing dental mass, characteristic of the molars of the existing dwarf-sloths of its continent.

When only the large curved pair of upper scalpriform incisors of *Diprotodon* were known, to which the subcompressed lower pair are opposed, an alliance of *Diprotodon* to *Phascolomys* was suggested. The subsequent evidence of a nearer affinity to *Macropus* instructively exemplifies the superior value of the molar teeth as indicators of the nature of an extinct animal*.

It is true that in the proportions of the limbs, especially in those of the tibia and its distinction from the fibula, as in some other particulars of the osteology of *Diprotodon*, it resembles more the Wombats than the Kangaroos; but the more weighty and essential correspondences are with the *Macropodidæ*; the equipedal modifications are adaptive and necessitated by the bulk of the extinct marsupial herbivore. The most elastic imagination could hardly stretch to the association of the disproportionate hind limbs of the Kangaroo with a trunk equalling that of a Rhinoceros; for according to that pattern, *Diprotodon* must have towered to a height of 30 feet. The departure from the type of its diminutive modern allies is, again, interestingly analogous to that which occurs in the herbivorous *Bruta*. The bulk and weight of body in *Megatherium* precluded the proportions of length and slenderness, with terminal prehensile instruments, in the limbs, by means of which its diminutive congeners and contemporaries have been enabled to withdraw themselves from an unequal conflict into the safe shelter of lofty trees. In like manner the bulk and weight of *Diprotodon* militated against its enjoying the privilege of the elongate saltatory limbs to which its small congeners and contemporaries the Kangaroos have owed their safety, or the scansorial ones by which the Koala climbs out of danger.

The analogies traceable between the extinct herbivorous giants of the two remote tracts of dry land are full of interest and instruction. I may add that as swift and continuous course and power of climbing are privileges checked or regulated by the mass and weight to be hurried along or dragged aloft, so likewise is the faculty of burrowing and concealment under ground. The *Diprotodon* was as impotent to avail itself of the means of escape to which the comparatively diminutive Wombats owe their present existence, at it was of the interposition of space, which the Kangaroo by a succession of long leaps, rapidly puts between itself and its pursuers.

Subject to this explanation the combination of Wombat- and Kangaroo-characters may be adduced as exemplifying that more generalized structure in *Diprotodon* from which, or from some earlier still more generalized marsupial type, have diverged the

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* Agreeably with the rule laid down by the great Founder of Palæontology; " La première chose à faire dans l'étude d'un animal fossile, est de reconnoître la forme de ses dents molaires; on détermine par-là s'il est carnivore ou herbivore, et dans ce dernier cas, ou peut s'assurer jusqu'à un certain point de l'ordre d'herbivores auquel il appartient," Cuvier, Ossemens Fossiles, 4to, vol. iii. 1812, p. 1 (Premier Mémoire).

three existing families with special modifications, respectively, for burrowing, climbing, and leaping; or, to borrow a figure from another hypothetical school, I might remark that the orders, or other natural groups, of placental Mammalia represented by members of the marsupial series have been indicated by different zoologists *, and with no material divergence of opinion; but not until now has evidence been received of a Marsupial representative of the proboscidian group.

In certain Mastodons there is a pair of incisive tusks below as well as above: the proboscidians maximize the rodent type as *Diprotodon* does the Marsupial one. The brain of the Elephant is essentially "lissencephalous," inasmuch as the cerebrum does not extend upon the cerebellum. This position of one primary mass of brain in front of the other is, as stated in the definitions of the subclasses of *Mammalia* in the cerebral system †, a more constant and important character than convolution of surface, which in both *ly-* and *liss-encephala* relates to the bulk of the species and of the brain. So, on the other hand, if a smooth cerebrum overlaps the cerebellum as in the Marmoset, it is essentially "gyrencephalous." The terms suggested by the superficial character which prevails, with exceptions, are arbitrary, but the most convenient for expressing the more constant characteristics of the brain therewith associated.

In the extinction of *Diprotodon*, as of *Megatherium*, there seems to be an additional exemplification of the fruitful and instructive principle which, under the phrases "contest for existence," or "battle of life," embodies the several circumstances, such as seasonal extremes, generative power, introduction of enemies, &c., under the influence of which a large and conspicuous quadruped is starved out, or falls a prey, while the smaller ones migrate, multiply, conceal themselves, and escape.

We infer from the fact of remains of young and inexperienced Diprotodons occurring in Australian Caverns with those of *Thylacoleo*, that the large Marsupial herbivore had its enemy in, and occasionally fell a victim to, the large Marsupial Carnivore‡; as at the present day the Kangaroo is laid in wait for by the Thylacyne, or 'Native Wolf', and the Dasyure, or 'Native Cat.'

We may speculate upon the possible relation of the first introduction of the Human kind into Australia, and of the subsequent insulation of that land from the rest of the Papuan Continent, to the final extinction in the so restricted territory of all the charac-

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* "On dirait, en un mot, que les marsupiaux forment une classe distincte, parallèle à celle des quadrupèdes ordinaires et divisible en ordres semblables; en sorte que si on plaçait ces deux classes sur deux colonnes, les sarigues, dasyures et péramèles seraient, vis-à-vis des carnassiers insectivores à longues canines, tels que les tenrecs et les taupes; les phalangers et les potoroos, vis-à-vis des hérissons et des musaraignes; les kangaroos proprement dits, ne se laisseraient guère comparer à rien; mais les phascolomes devraient aller vis-à-vis des rongeurs."—CUVIER, Règne Animal, ed. 1817, tom. i. p. 171. "Les ornithorhynches et les échidnés y formeraient un groupe parallèle à celui des édentés."—*Op. cit.* ed. 1829, tom. i. p. 174.

† OWEN, "On the Characters &c. of the class Mammalia," Proceedings of the Linnean Society, 1857.

‡ I shall return to the question of the evidence of the carnivority of *Thylacoleo* in a subsequent communication.

teristic Mammals which happened to surpass in bulk the still existing, swift-retreating, saltatorial and nocturnal Kangaroos.

It is true that reliable evidence has not reached us of the contemporaneity of Man with *Diprotodon* in Australia. No human tooth or bone, no weapon fashioned by man, has hitherto been detected in the breccia-caves, or has been picked up in the lacustrine beds in South Australia, Queensland, and Melbourne, from which the largest and oldest Diprotodonts have been exhumed, mostly under conditions of petrifaction, suggestive of interment in those deposits during a vastly longer period than the Mammoths and Rhinoceroses have lain in our own brick-fields.

A human skeleton, or part of it, picked out of the deposits forming the bed of a tributary of the Condamine, and yielding the same results of chemical analysis as are recorded of a Diprotodont fossil at p. 572, would be one of the much needed decisive and satisfactory evidences of the antiquity of Man. To promote the investigation in the Australian Continent which the present phase of the ancient history of our own species so much requires, I ventured some time ago to address the Legislature of New South Wales, and with results, as respects the aid and encouragement of such researches, which are given in the subjoined notes*.

The range of *Diprotodon australis*, during the period of its existence, in the Australian Continent is shown by the evidence at present possessed to have been wide.

* " London, British Museum,
23rd February, 1867.

" SIR,—The enlarged and liberal views of your administration embolden me to suggest that a careful and systematic exploration of the Limestone-caves of Wellington Valley, discovered by the Colonial Surveyor in or about 1832, would be a work worthy of your encouragement.

" The fossil remains which were then obtained from the caves revealed the important and suggestive fact that the marsupial type of structure prevailed in the ancient and extinct as in the existing quadrupeds of Australia.

" Besides the great accession of such evidences as would accrue to the Museum at Sydney from such exploration, most instructive evidence may be expected bearing upon the antiquity and origin of the aboriginal races of Australia. Such contribution to human knowledge, initiated and supported by New South Wales, would be gratefully appreciated by all who in this hemisphere are devoted to the progress of science, and would redound to the honour of your present constitutional Government.

" I would willingly devote time to the determination and description of such specimens, or duplicates, as, so acquired, might be transmitted to me for that purpose, or be liberally sent for deposition in the British Museum ; and these descriptions would be punctually transmitted to the Museum at Sydney, as materials of its Catalogue, or to such address as you might be pleased to indicate, in reference to a systematic description of the Wellington Valley Bone-caves.

" I feel confident, from personal conference on the subject with the late Sir THOMAS MITCHELL, who confided to me the fossils he was able to bring over for description in his work published in 1838, that the results of the proposed exploration, in the hands of one qualified, would amply repay a grant, say of £200 or £300, if placed on the estimates and sanctioned by the Assembly.

" I have, &c.,
(Signed)   " RICHARD OWEN, F.R.S."
" The Hon. HENRY PARKES, &c.,
    Colonial Secretary, New South Wales."

Table of Localities of *Diprotodon australis*, showing :—

Where found.	By whom.	Date.
Breccia-cavern, Wellington Valley*	Sir Thomas Mitchell, C.B.	1836
Tributaries of Condamine River, Darling Downs†	Sir Thomas Mitchell, C.B.	1842
Quaternary gravel, Mount Macedon, Melbourne‡	E. C. Hobson, M.D.	1843–45
Tributaries of Condamine River, Darling Downs§	Ludwig Leichhardt, M.D.	1844
Freshwater beds, Mount Macedon, Melbourne‖	Patrick Mayne, Esq.	1844
Bone-caves, Wellington Valley	Count Strzelecki	1844
King's Creek, Darling Downs	Mr. Turner	1847
Gowrie, Darling Downs¶	Fred. Neville Isaac, Esq.	1849
Galtendaddai, Melville Plains	Wm. Buchanan, Esq.	1851
Creeks, Darling Downs	Henry Hughes, Esq.	1856
Gowrie, Darling Downs	John E. Allport, Esq.	1860
Welcome Springs, South Australia**	Fred. Geo. Waterhouse, Esq.	1861
Valley of Condamine††	J. H. Hood, Esq.	1861
Portland Bay, South Australia	James S. Wilson, Esq.	1860
Hergott's Springs, Mount Attraction, 500 miles N. of Adelaide ‡‡	William Burrett, Esq.	1861
Eton Vale, middle of Darling Downs	Edward S. Hill, Esq.	1863
St. Ruth Station, Tributary of Condamine River	Hugh Campbell, Esq.	1865
St. Jean Station, Queensland	M. Satche St. Jean	1865
Clifton Plains, Darling Downs	F. Nicholson, Esq.	1866
Breccia-cavern, Wellington Valley	Gerard Krefft, Esq.	1866

To this letter I was favoured with the following reply :—

(Copy.)

" Colonial Secretary's Office, Sydney, New South Wales,
16th June, 1869.

" Sir,—With reference to your letter of the 23rd of February, 1867, recommending that the Government of this Colony should cause a careful and systematic exploration to be made of the Limestone-caves of Wellington Valley, I have now the honour to inform you that the sum of £200 has been voted by the local Parliament for carrying out your suggestion, and that the Curator of the Australian Museum has been charged with the duty of making the necessary exploration.

" I have the honour to be, Sir,

" Your most obedient Servant,

(Signed)   " JOHN ROBERTSON, Colonial Secretary."

" To Professor OWEN, F.R.S."

I was gratified by reading in 'The Times' of December 1st, 1869, a notice from the Sydney Correspondent of that Newspaper to the effect that " the Wellington Bone-caves have been explored by Dr. A. M. THOMSON and Mr. KREFFT of the (Sydney) Museum, with astonishing and unexpected results."

* See description of these Bone-caves by their discoverer in his 'Three Expeditions into the Interior of Eastern Australia,' 8vo, vol. ii. 1838.

† Sir T. MITCHELL places the locality in lat. 28° S., long. 150° E.; and of the Condamine, he writes: " This stream is remarkable from forming large basins at some places and losing its course in swamps at others, and at other parts again cutting its course in a deep channel, through deep beds of alluvium, in which these bones [of *Diprotodon*] are thus brought to light."—Letter dated January 3, 1842.

‡ Dr. HOBSON, in transmitting these specimens, sent a sketch of the locality with the following Note :—

" The country from Melbourne is volcanic the whole way; indeed the bank which borders the estuary on which the town is built is the commencement of vast elevated plains of volcanic origin, covered with vesicular lava, scoriæ, interrupted by deep ravines, which show on their steep sides, in many places, a regular columnar basaltic arrangement. Of this nature is the entire country betwixt Mount Macedon and Melbourne, gradually rising, but so slightly as to be almost imperceptible, till you arrive at the volcanic hills that immediately surround Mount Macedon, which is, I believe, composed of granite on its top, and of schistose slates on its side.

The fossils from Mount Macedon are less petrified than those from Darling Downs: the osseous substance crumbles away if not supplied with gelatine, like the fossil bones and tusks from our brick-earth in England.

"Amongst the secondary hills which skirt the base of Mount Macedon there is a considerable circular plane, which is more elevated in its centre than at its circumference, and which will be better explained by a diagram :—
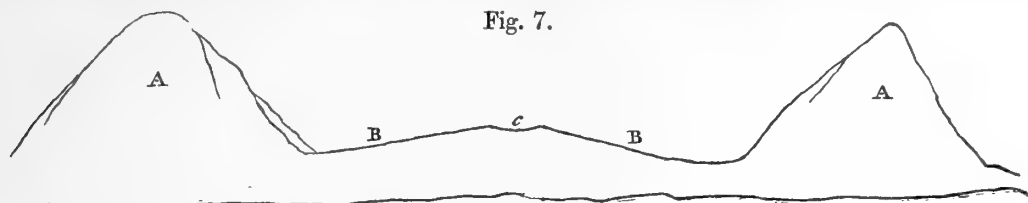
Fig. 7.

A, A. Volcanic Hills surrounding the plain.

B B. The plain.

c. A swamp or bog in which are found the bones at a depth of $4\frac{1}{2}$ feet.   After digging through a solid peaty soil for 3 feet you then arrive at a stratum of gravel about 18 inches thick, in which the bones are deposited. This layer of gravel rests upon a bed of firm clay, which is unfossiliferous.

"The bog or marsh in which the bones are found is about four acres in extent, and appears to contain bones at every point.   I opened two pits at 150 yards distance from each other and found bones in both, in the same stratum of gravel."—Letter dated January 1st, 1845.

§ The following valuable Note on the formations of the locality accompanied the transmission of the fossils, by the gifted and unfortunate explorer of that part of Australia :—

"The Darling Downs are extensive plains, formed by broad shallow valleys, without trees, covered only with grass and herbage, which grows luxuriantly on the rich black soil, in which concretions of carbonate of lime are frequently found.   Ranges of low hills, forming long simple lines with sudden slopes and flat-topped cones, accompany these valleys, and have an open forest formed of various species of rather stunted *Eucalyptus*.   All these hills are formed by a basaltic rock, containing frequently crystals of peridote, and being often cellular, sometimes real scoria.   The base of the rock is, however, feldspathic; and, as the peridote is frequently absent, the rock becomes uniformly grey, forms a white globule before the blowpipe, and is therefore to be classed amongst the trachytes or phonolites.   The plains are filled by an alluvium of considerable depth, as wells, dug 50–60' deep, have been sunk within it.   The plains and creeks in which the fossil bones have been found are 'Mr. Hodgson's Creek,' 'Campbell's Creeks,' 'Mr. Isaac's Creek,' and 'Oaky Creek.'   They pass all into and through immense plains on the west side of the Condamine, into which they fall.   The bones are either found in the bed of the creek, particularly in the mud of dried up water-holes, or in the banks of the creeks in a red loamy breccia, or in a bed of pebbles, containing many trachytic pebbles of the coast range from the west side of which these creeks descend.

"In the banks of the creeks you find at first the rich black soil of the plain, about 3' thick, then layers of clay and of loam, here and there, particularly at 'Isaac's Creek,' with marly concretions of strange irregular forms. The masses of these concretions are often of considerable thickness, though not extending far horizontally.   The loam contains small broken pieces of ironstone (breccia) and is equally local.   Below these the bed of pebbles lies.   The bones found in the breccia are generally near the concretions, but not with them, or they occur amongst the pebbles.   A very interesting fact is the presence of univalve and bivalve shells, which live still in the neighbouring water-holes, in the same beds, in which the bones are found.   They are either intimately united with the bones by a marly cement, or they occur independently.   The greatest depth in which bones are found is 12'.   At 'Oaky Creek' we found them at the surface.   Besides the bones of the gigantic animal, there are lower jaws and different parts of the skeleton of four other Kangaroos, many of them little different from the living ones, and probably identical with those of Wellington Valley.   It seems to me that the conditions of life can have very little changed, as the same shells live still in similar water-holes.   The want of food can

I subjoin the analysis of bones and teeth of *Diprotodon australis*, from the beds of the creeks, Darling Downs, by WALTER FLIGHT, D.Sc., Assistant in the Department of Mineralogy of the British Museum.

" Laboratory, Mineral Department, British Museum,
21st January, 1870.

" DEAR SIR,—I have the honour to lay before you a Report on the chemical examination of a portion of a jaw-bone of the Diprotodon, which was received from Professor OWEN at the end of last year.

" The method, devised by M. SCHEURER-KESTNER, and described by him in the 'Comptes Rendus,' vol. lxix. p. 1207, was employed in this inquiry, and the following analytical determinations were made.

" 1·2462 gramme of bone, treated with 108 cub. centims. of hydrogen chloride, of specific gravity 1·04 (from 5° to 6° BAUMÉ), for twenty-two hours at ordinary temperatures, left a residue which, after having been dried at 100° C. till it ceased to lose weight, amounted to 0·1953 gramme, and, after ignition, to 0·1772 gramme. By this treatment the calcium phosphate, carbonate, and fluoride iron phosphate, &c., as well as the 'soluble osseine' of SCHEURER-KESTNER, are taken up by the acid, and there remain 14·259 per cent. of insoluble mineral matter (chiefly silica coloured red with iron peroxide) and 1·452 per cent. loss of weight by ignition, which in the memoir alluded to is taken to be insoluble osseine.

" The pounded bone, however, when heated did not change in colour to any great degree, nor emit the expected characteristic odour. A nitrogen determination was next made with the following result. 0·541 gramme of bone, heated with soda-lime, and the resulting platinum ammonium chloride ignited, gave 0·002 gramme of platinum. This amount of the metal corresponds with 0·00028 gramme of nitrogen. Assuming that gelatine contains 17·5 per cent. of nitrogen, the above nitrogen corresponds with 0·0016 gramme of osseine, or 0·295 per cent.

" The bone therefore contains about $\frac{1}{4}$ per cent. of osseine altogether; and the loss of weight, amounting to 1·452 per cent., and regarded by SCHEURER-KESTNER as due to insoluble osseine, must be ascribed to a further loss of water which was not expelled at the temperature of 100° C.

" As the amount of matter insoluble in hydrogen chloride appeared unusually large (14·259 per cent.), it was thought that the action of the acid might not have been complete. In spite of my failing to detect phosphoric acid in this portion, I nevertheless thought it advisable to subject a further quantity of the bone to the action of a corresponding amount of acid of the same strength for a longer period. 1·0468 gramme of bone digested with 90·5 cub. centims. of hydrogen chloride for sixty-eight hours at ordinary temperatures left a residue weighing 0·1418 gramme, which, when ignited, was reduced to 0·1341 gramme. In this case, then, 12·81 per cent. of mineral matter remained undissolved, whilst the loss by ignition amounted to 0·735 per cent.

" With a view to determine the water present in this bone, 2·5046 grammes were heated for several hours, first at 100° C. and after at 120° C. ; the water lost amounted to 0·0932 gramme, or 3·721 per cent. After ignition and treatment with ammonium carbonate, the total loss was 0·1446, or 5·774 per cent. Subtracting

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scarcely be the cause of their disappearing, as flocks of sheep and cattle pasture over their fossil remains. But as such an herbivore must have required a large body of water for his sustenance, the drainage of these plains, or the failing of those springs, the calcareous waters of which formed the concretions in the banks of the creeks, has been probably the cause of their retiring to more favourable localities, and I should not be surprised if I found them in the tropical interior, through which I am going to find my way to Pt. Essington."—Letter dated " Sydney, 10th July, 1844."

" Found about 6 feet below the surface in sinking a well."—Note by Mr. MAYNE.

¶ " In the 'red bank' of this [Isaac's] creek."—Note by Mr. ISAAC.

** Found about 8 feet below the surface in sinking a well, lat. 137' 50" S., long. 39' 35" E.—Note by Mr. F. G. WATERHOUSE.

†† " From 100 feet below the surface, in digging a well, in the valley of the Condamine River."—Note by Mr. HOOD.

‡‡ " They were taken from a bed of sand and quartz conglomerate, at a depth of about 5 feet."—Note by Mr. BURKETT.

from this number the amount of osseine present (0·295 per cent.), there remain 5·479 per cent., the proportion of water present in the bone.

" It may be mentioned that the bone contained a considerable quantity of vivianite, which gave to portions of its interior a dull blue colour.

" *Analysis of Substances filling cavity of tooth of* Diprotodon [Pulp-cavity of lower incisor, Plate XLII. fig. 5, *i.*—R. O.].

" The nitrogen in a portion of the above, which had been dried for many hours at 100°, was determined by the usual method.

" 0·9814 gramme of substance, heated with soda-lime, gave 0·0071 gramme platinum, which corresponds with 0·001 gramme nitrogen.

" Regarding this nitrogen as present in the form of osseine, and employing the number obtained by FRÉMY (17·5 per cent.) in his analysis of the gelatine of beef-bone as correctly representing the percentage of nitrogen in osseine, we find the substance from this fossil tooth to contain 0·58 per cent. of osseine.

" When heated in a tube it became slightly darker in colour, and emitted a faint empyreumatic odour.

" It was found to be composed of

Much carbonate lime,
Some phosphate lime,
Much silica, iron oxide, &c.,
Some water not removable at 100°,
The small portion of organic matter already mentioned.

" I am, dear Sir,

" Your obedient Servant,

" To Professor STORY-MASKELYNE,   " WALTER FLIGHT."

Keeper of the Mineral Department, British Museum."

TABLE OF ADMEASUREMENTS.

Skull.

	Feet.	Inches.	Lines.
Length from occipital condyle to fore end of premaxillary	3	0	0
Breadth between outer sides of zygomata	1	6	0
Depth to lower border of mandible at the orbit	1	10	0
Depth to outlet of socket of upper *m* 1, at the orbit	1	0	0
Breadth of occiput	1	1	0
From lower border of foramen magnum to middle of superoccipital ridge	0	9	9
Breadth of cranium at middle of temporal fossa and at the level of the upper part of the zygomata	0	6	6
Depth of facial part anterior to the orbit	0	8	0
Depth of facial part at fore end of nasals	0	10	0
Depth of zygoma at the lower end of the malomaxillary suture	0	4	0
Length of mandible from back of condyle to outlet of incisive sockets	2	0	0
Depth from summit of coracoid process	1	1	0
Fore-and-aft breadth of ascending ramus	0	7	0
Depth of horizontal ramus at the socket of *m* 1	0	5	0
Length of symphysis	0	6	0
Greatest depth of symphysis	0	3	6
Length of upper incisive alveolar series	0	4	6
Length of upper molar alveolar series	0	8	6
Length of lower molar alveolar series	0	9	0

Vertebræ.

	Feet.	Inches.	Lines.
Length of vertebra dentata, including odontoid process	0	6	3
Height of vertebra dentata, including odontoid process	0	8	4
Length of the body of third cervical vertebra	0	1	10
Breadth of the body of third cervical vertebra	0	4	3
Height of third cervical vertebra	0	8	0
Length of the body of an anterior dorsal vertebra	0	2	0
Breadth of the body of an anterior dorsal vertebra	0	4	10
Height of the same vertebra	0	10	6
Length of the body of an anterior lumbar vertebra	0	2	4
Length of the body of a posterior lumbar vertebra	0	3	3
Breadth of the body of a posterior lumbar vertebra	0	5	0
Longitudinal extent of sacrum	0	6	0

Scapula.

	Feet.	Inches.	Lines.
Length	2	5	0
Breadth, across the humeral end	1	2	0
Breadth, of base, at subsidence of spine	0	6	0

Humerus.

	Feet.	Inches.	Lines.
Length	2	6	6
Circumference (least) of shaft	0	10	0
Breadth (transverse) of upper proximal end	0	6	0
Breadth (transverse) of lower end	0	9	6
Breadth, extreme (transverse), of lower articular surface	0	6	10
Breadth (fore-and-aft) of radial condyle	0	3	6
Breadth (fore-and-aft) of ulnar condyle	0	3	0
Breadth (fore-and-aft) of intermediate trochlea	0	1	11

Pelvis.

	Feet.	Inches.	Lines.
Breadth across fore part of ilia	2	8	0
Breadth across antero-inferior iliac spines	1	9	0
From fore part of sacro-iliac symphysis to the ischial spine	0	10	6
From hind part of sacro-iliac symphysis to the ischial spine	0	4	0
Breadth between ischial spines	0	6	9

Femur.

	Feet.	Inches.	Lines.
Length	2	6	0
Circumference (least) of shaft	1	0	0
Breadth (transverse) of upper end	1	3	6
Breadth (extreme transverse) of lower end	0	8	6
Circumference of head	1	2	0
Breadth (transverse) of middle of shaft	0	4	5
Breadth (fore-and-aft) of middle of shaft	0	2	6
Breadth (fore-and-aft) of inner condyle	0	7	9

Tibia.

	Feet.	Inches.	Lines.
Length	1	5	9
Circumference (least) of shaft	0	8	0
Breadth (transverse) of upper end	0	8	0
Breadth (greatest) of lower end	0	5	0

DESCRIPTION OF THE PLATES.

PLATE XXXV.

Fig. 1. Side view of skull of *Diprotodon australis*:—one-fifth nat. size.

Fig. 2. Back view of skull of *Diprotodon australis*:—one-fifth nat. size.

Fig. 3. Front view of skull of *Diprotodon australis*:—one-fifth nat. size.

Fig. 4. Proportions of malar and squamosal forming glenoid cavity:—one-fifth nat. size.

Fig. 5. Side view of skull, in outline, of *Macropus laniger*:—one-fifth nat. size.

PLATE XXXVI.

Fig. 1. Outer side of first incisor, upper jaw:—nat. size.

Fig. 2. Inner side of first incisor, upper jaw:—nat. size.

[An extent of an inch of the tooth is wanting at the place of fracture.]

Fig. 3. Outer or enamelled side of working extremity of a first incisor.

Fig. 4. Outer or enamelled side of working extremity of a first incisor from another individual.

Fig. 5. Section, vertical and transverse, of premaxillary alveoli, with the first incisors, *i* 1, *in situ*: *i* 2, end of the socket of the second incisor; *i* 3, part of that of the third incisor.

Fig. 6. Basal or inserted end of first incisor; the margin mutilated.

Fig. 7. Basal or inserted end of second incisor.

All the figures are of the natural size.

PLATE XXXVII.

Fig. 1. Outer side view of the right upper molars, *in situ*, of probably a female *Diprotodon*.

Fig. 2. Grinding-surface of ditto.

Fig. 3. The three last molars of another *Diprotodon*.

Fig. 4. Grinding-surface of crown of last molar (*m* 3) of a larger *Diprotodon*.

Fig. 5. Front view of the same tooth.

Fig. 6. Back view of the same tooth.

All the figures are of the natural size.

PLATE XXXVIII.

Fig. 1. Outer side view of the right upper molars, *in situ*, of a large, probably male, *Diprotodon*.

Fig. 2. Grinding-surface of ditto, with part of bony palate.

Fig. 3. Hind surface of last molar (*m* 3) of another *Diprotodon*.

Fig. 4. Front surface of the same tooth.

All the figures are of the natural size.

PLATE XXXIX.

Fig. 1. Outside view of last upper molar (*m* 3) of a small, probably female, *Diprotodon*.
Fig. 2. Outside view of last upper molar (*m* 3) of a larger, probably male, *Diprotodon*.
Fig. 3. Sockets and ends of roots of penultimate and last upper molars.
Fig. 4. Outside view of lower incisor [an extent of an inch is wanting at the place of fracture].
Fig. 5. Working surface of exposed end of lower incisor.
Fig. 6. Transverse section at its emergence from the socket.
Fig. 7. Side view of second upper incisor (*i* 2).
Fig. 8. Working surface of the same tooth.

PLATE XL.

Molar teeth of the lower jaw.

Fig. 1. Outer side view of second molar (*d* 4) of a young *Diprotodon*.
Fig. 2. Working surface of second molar (*d* 4) of a young *Diprotodon*.
Fig. 3. Working surface of second molar of an older, probably female, *Diprotodon*.
Fig. 4. Working surface of second molar of an old, probably male, *Diprotodon*.
Fig. 5. Outer side view of third molar (*m* 1) of a young *Diprotodon*.
Fig. 6. Working surface of third molar (*m* 1) of a young *Diprotodon*.
Fig. 7. Working surface of third molar (*m* 1) of an older, probably female, *Diprotodon*.
Fig. 8. Working surface of third molar (*m* 1) of an old, probably male, *Diprotodon*.
Fig. 9. Outer side view of fourth molar (*m* 2) of a young *Diprotodon*.
Fig. 10. Working surface of fourth molar (*m* 2) of a young *Diprotodon*.
Fig. 11. Working surface of fourth molar (*m* 2) of mature, probably male, *Diprotodon*.
Fig. 12. Outer side view of crown of germ of fifth molar of a young *Diprotodon*.
Fig. 13. Front view of fifth molar of a mature *Diprotodon*.
Fig. 14. Working surface of penultimate lower molar of *Macropus Atlas*.
Fig. 15. Working surface of penultimate lower molar of a Malayan Tapir.
Fig. 16. Working surface of crown of incomplete fifth molar of a young *Diprotodon*.
Fig. 17. Working surface of penultimate molar (*m* 2) of an old *Diprotodon*.
Fig. 18. Working surface of last molar (*m* 3) of an old *Diprotodon*.
Figures 1, 2, 5, 6, 9, 10, 12, 16 are from the same individual.
All the figures are of the natural size.

PLATE XLI.

Fig. 1. Outside view of anterior part of mandible and teeth (*i* 1, *d* 4, *m* 1) of an immature *Diprotodon*: the first molar (*d* 3) is given in outline.
Fig. 2. Inside view of anterior part of the same mandible and teeth (*i* 1, *d* 3 restored in outline, *d* 4, *m* 1).

PLATE XLII.

Fig. 1. Section of upper molars (*m* 1, *m* 2, *m* 3) of a mature, not old, *Diprotodon*.
Fig. 2. Inside view of mandible and teeth of ditto : reduced to one-sixth.
Fig. 3. Back view of mandibular condyle : reduced to one-sixth.
Fig. 4. Front view of ditto.
Fig. 5. Section of anterior part of mandible and incisor tusk of an immature *Diprotodon*.

PLATE XLIII.

Fig. 1. Axis, or vertebra dentata :—nat. size.
Fig. 2. Portion of atlas vertebra :—nat size.

PLATE XLIV.

Fig. 1. Front view of axis.
Fig. 2. Under view of axis.
Fig. 3. Back view of axis.
Fig. 4. Back view of third cervical vertebra.
Fig. 5. Back view of an anterior dorsal vertebra.
Fig. 6. Side view of the same dorsal vertebra.
Fig. 7. Side view of a succeeding dorsal vertebra.
Fig. 8. Back view of the same vertebra.
Fig. 9. Side view of the body of a lumbar vertebra.
Fig. 10. Back view of ditto.
Fig. 11. Under view of ditto.
Fig. 12. Epiphyses of the body of a cervical vertebra: *a*, edge- or side-view.
Fig. 13. Epiphyses of the body of a lumbar vertebra: *a*, edge-view.
           All the figures are one-third the natural size.

PLATE XLV.

Fig. 1. Outer surface or " dorsum" of the left scapula.
Fig. 2. Inner or subscapular surface of the left scapula.
Fig. 3. Articular end, with glenoid cavity of the left scapula.
           One-third the nat size.

PLATE XLVI.

Fig. 1. Back view of left humerus.
Fig. 2. Front view of left humerus.
Fig. 3. Proximal end of left humerus.
Fig. 4. Distal end of left humerus.
Fig. 5. Inner side view of distal third of a right humerus.
           One-third the nat. size.

PLATE XLVII.

Fig. 1. Under or "hæmal" view of the pelvis

Fig. 2. Upper or "neural" view of the sacrum and right half of the pelvis.

Fig. 3. Front view of the sacrum.

Fig. 4. Acetabular cavity.

[See 'Admeasurements' in text for scale of reduction.]

PLATE XLVIII.

Fig. 1. Front view of femur.

Fig. 2. Outside view of femur.

Fig. 3. Section of middle of shaft of femur.

Fig. 4. Lower articular end of femur.

Fig. 5. Inside view of lower end of femur.

One-third nat. size.

PLATE XLIX.

Fig. 1. Hind view of femur.

Fig. 2. Front view of tibia.

Fig. 3. Outside view of tibia.

Fig. 4. Upper end of tibia.

Fig. 5. Lower end of tibia.

Plate L.

Restoration of the skeleton of *Diprotodon australis*:—one-twelfth nat. size.
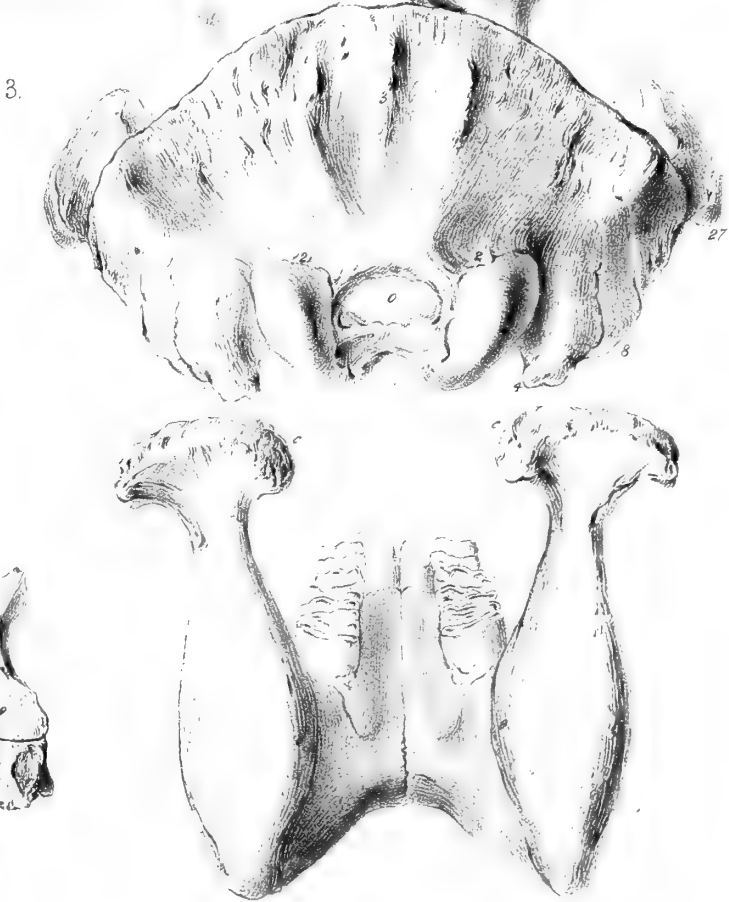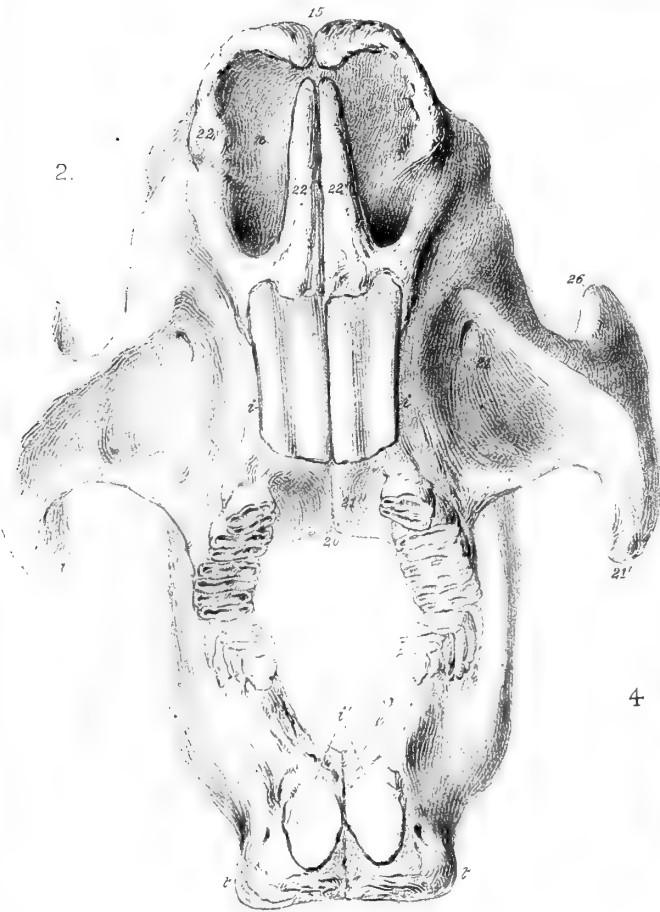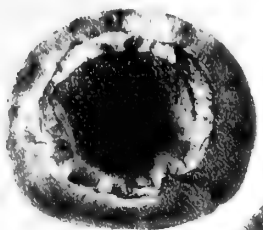
Fig 1

Fig 1

Fig 2

Fig 6

Fig 5

Fig 3

Fig 4

Fig. 1

m^3 b m^2 a m^1 d^4

Fig 2.

g h

g f f g f

Fig. 3.

m^3 m^2 d m^1 e f

Fig. 5.

l

m

n

Fig. 6

l

n

Fig. 4

g f

b m^3 a
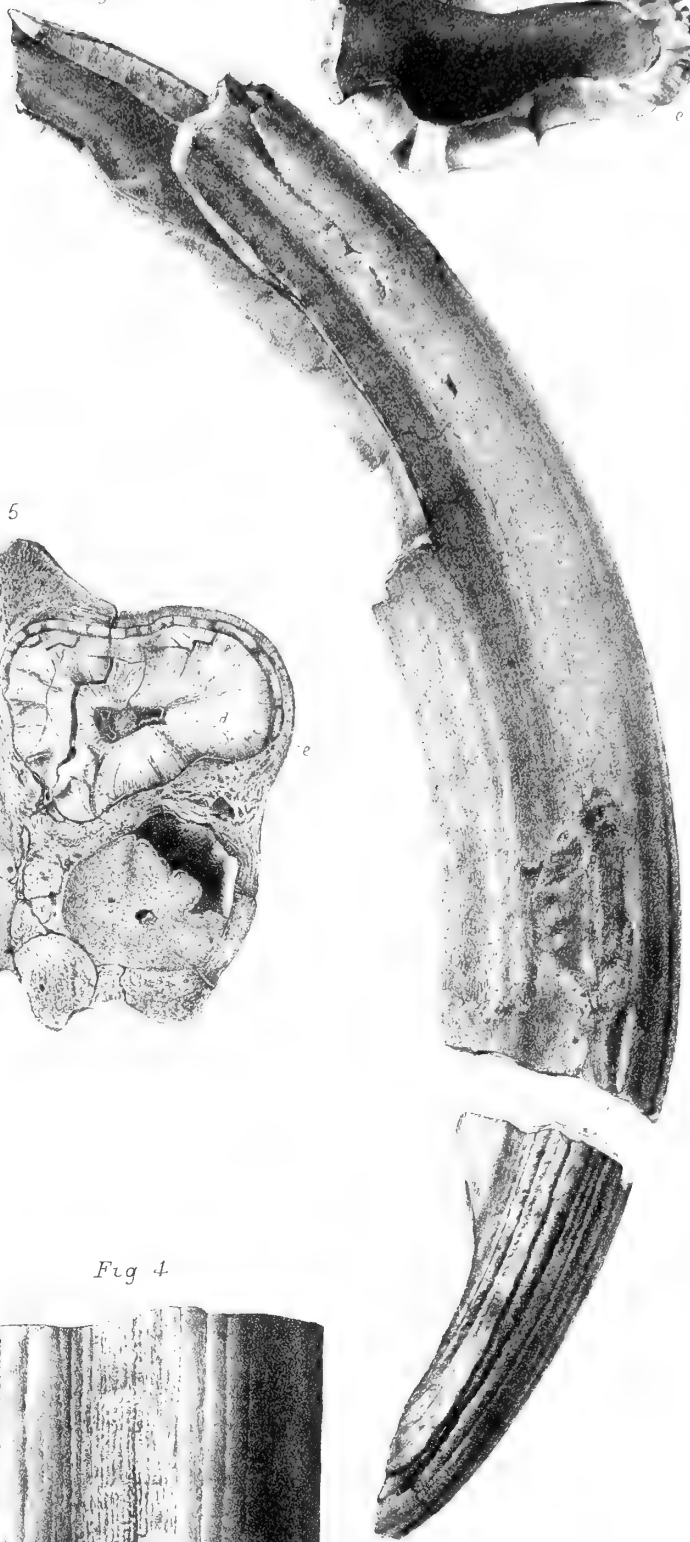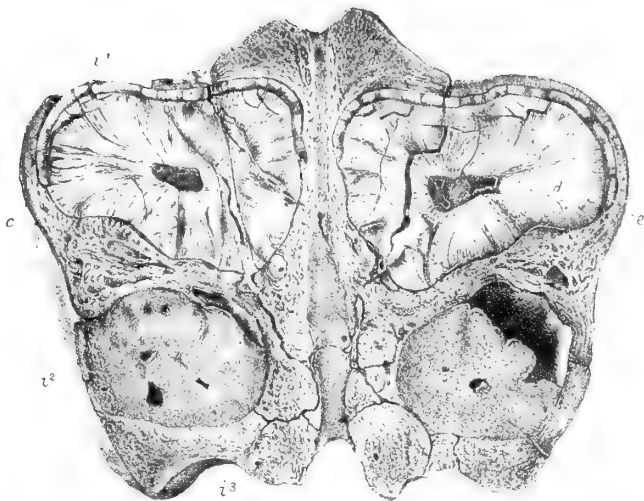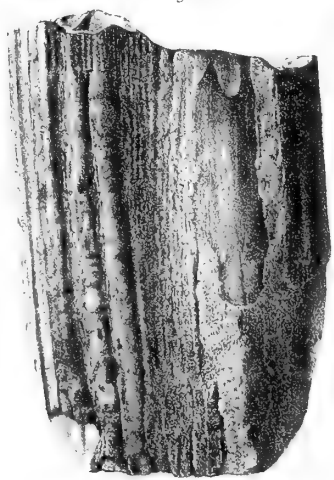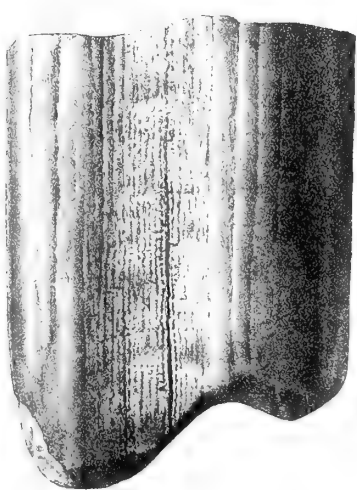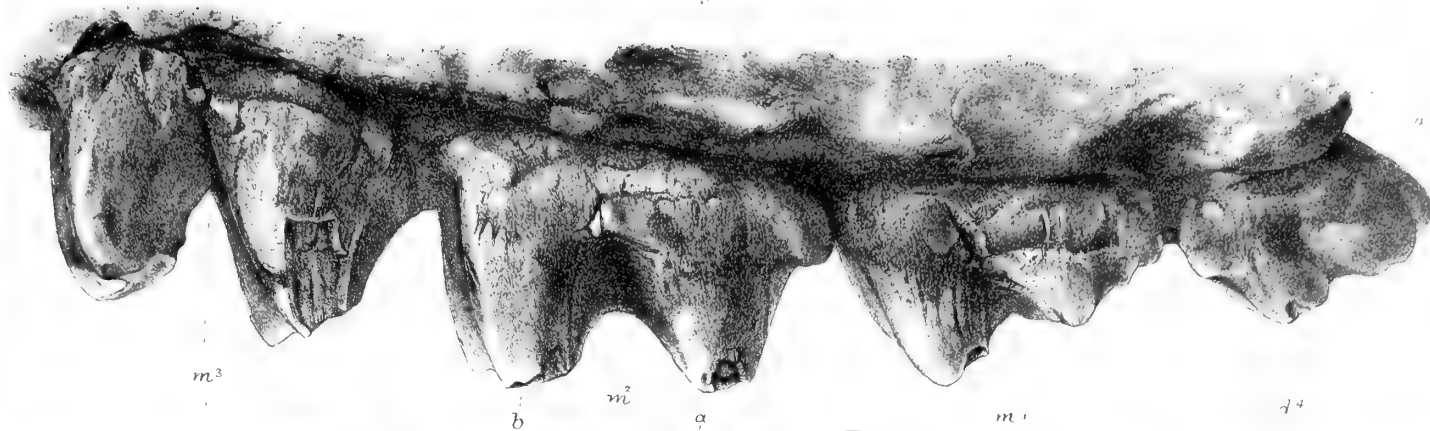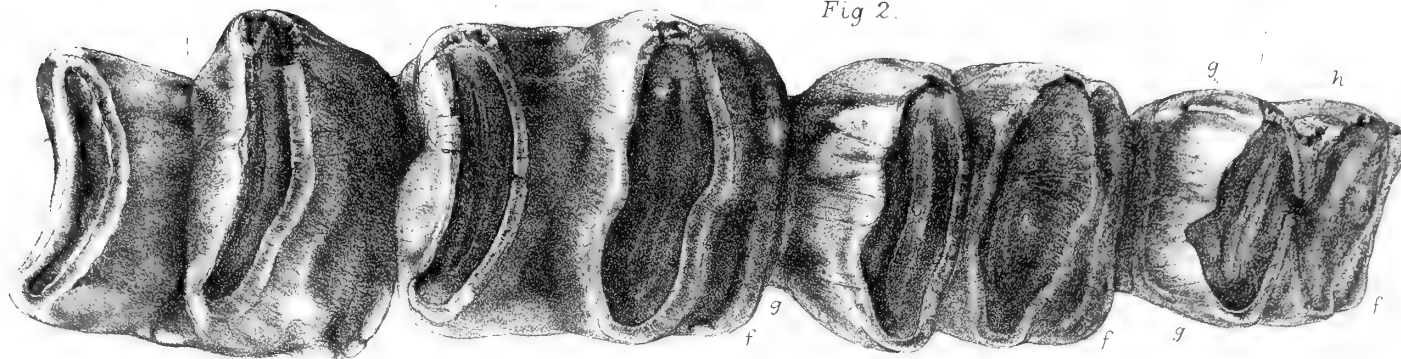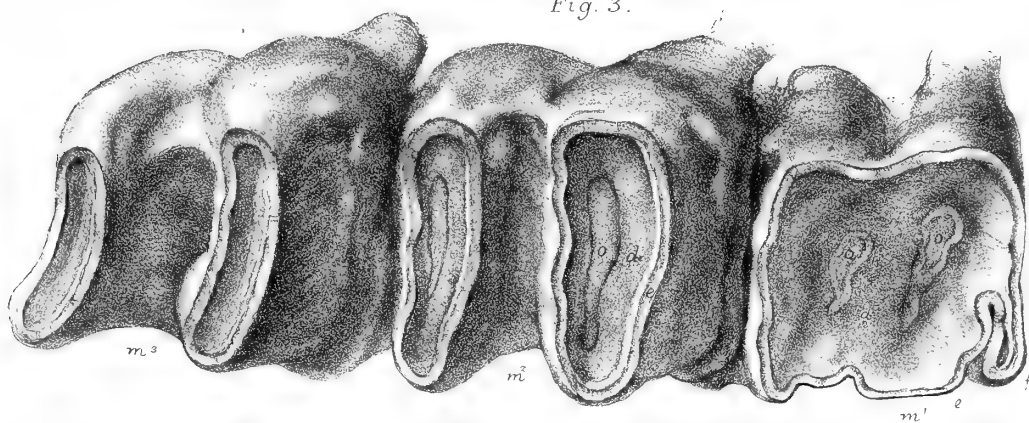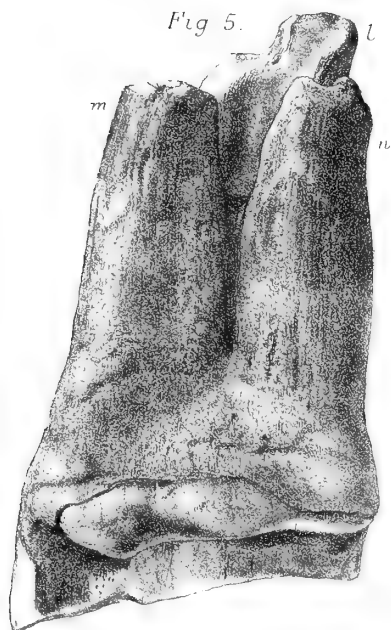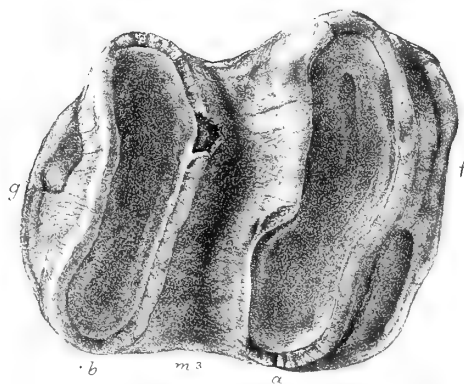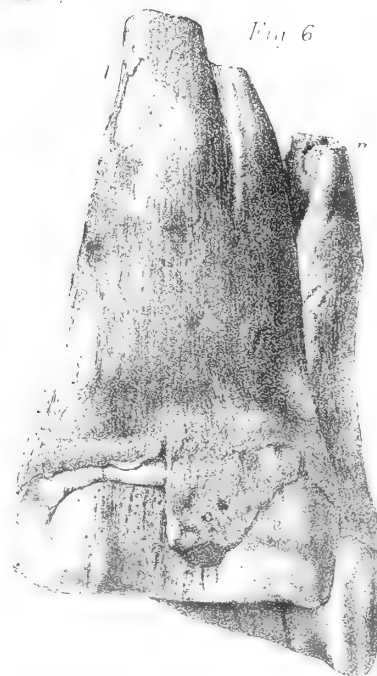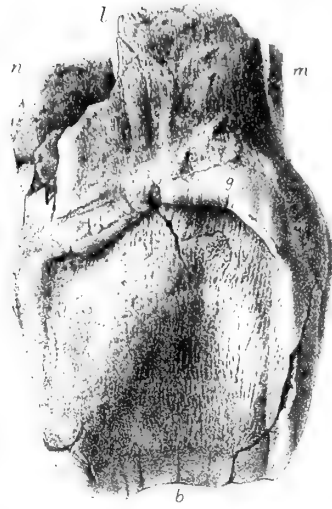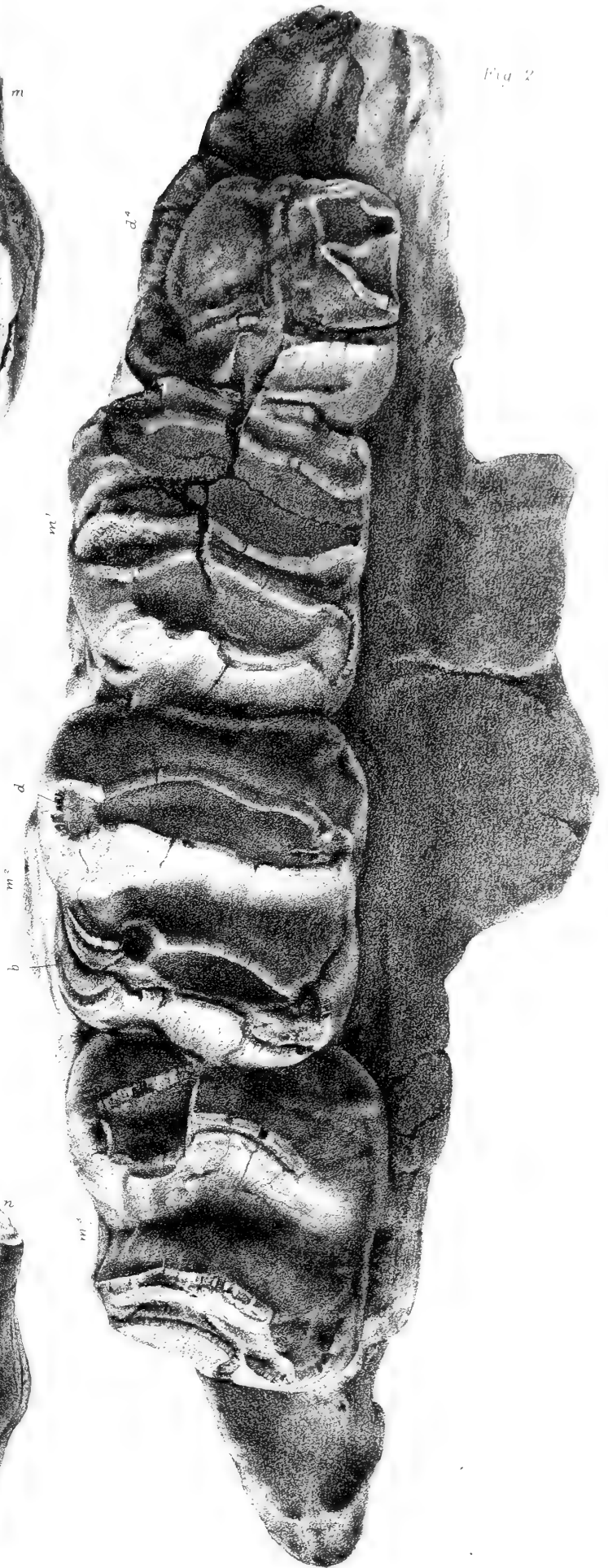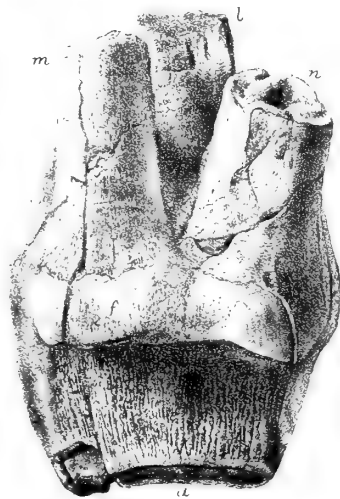
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig 1

Fig 7.
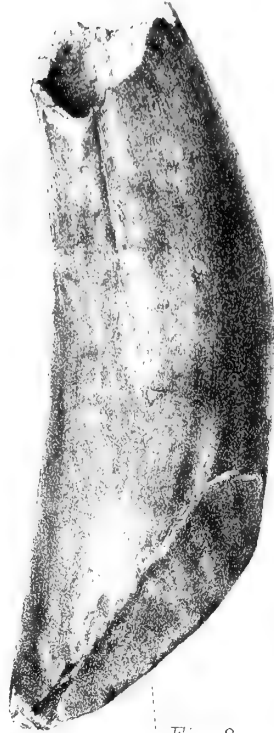
Fig. 5.

Fig 4.

Fig 2

Fig 8

Fig 6

Fig. 3.

Fig. 1

Fig. 2

LOWER TEETH, YOUNG DIPROTODON
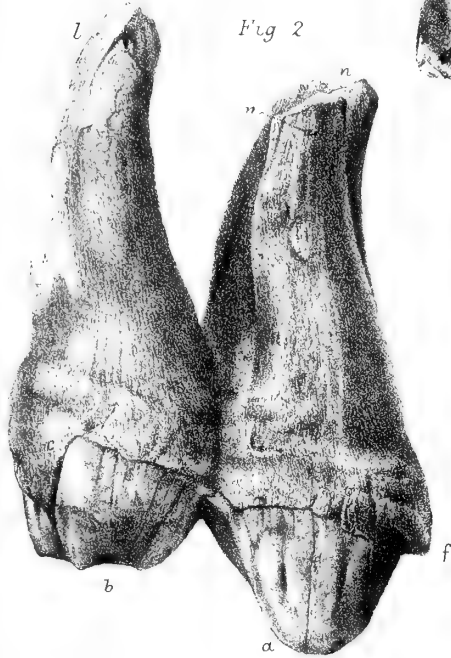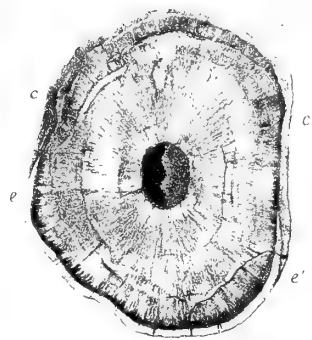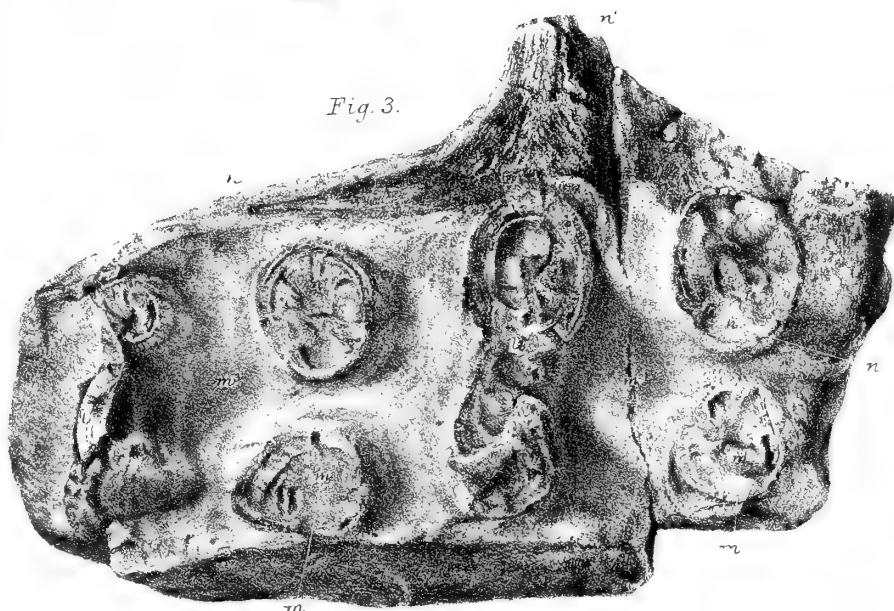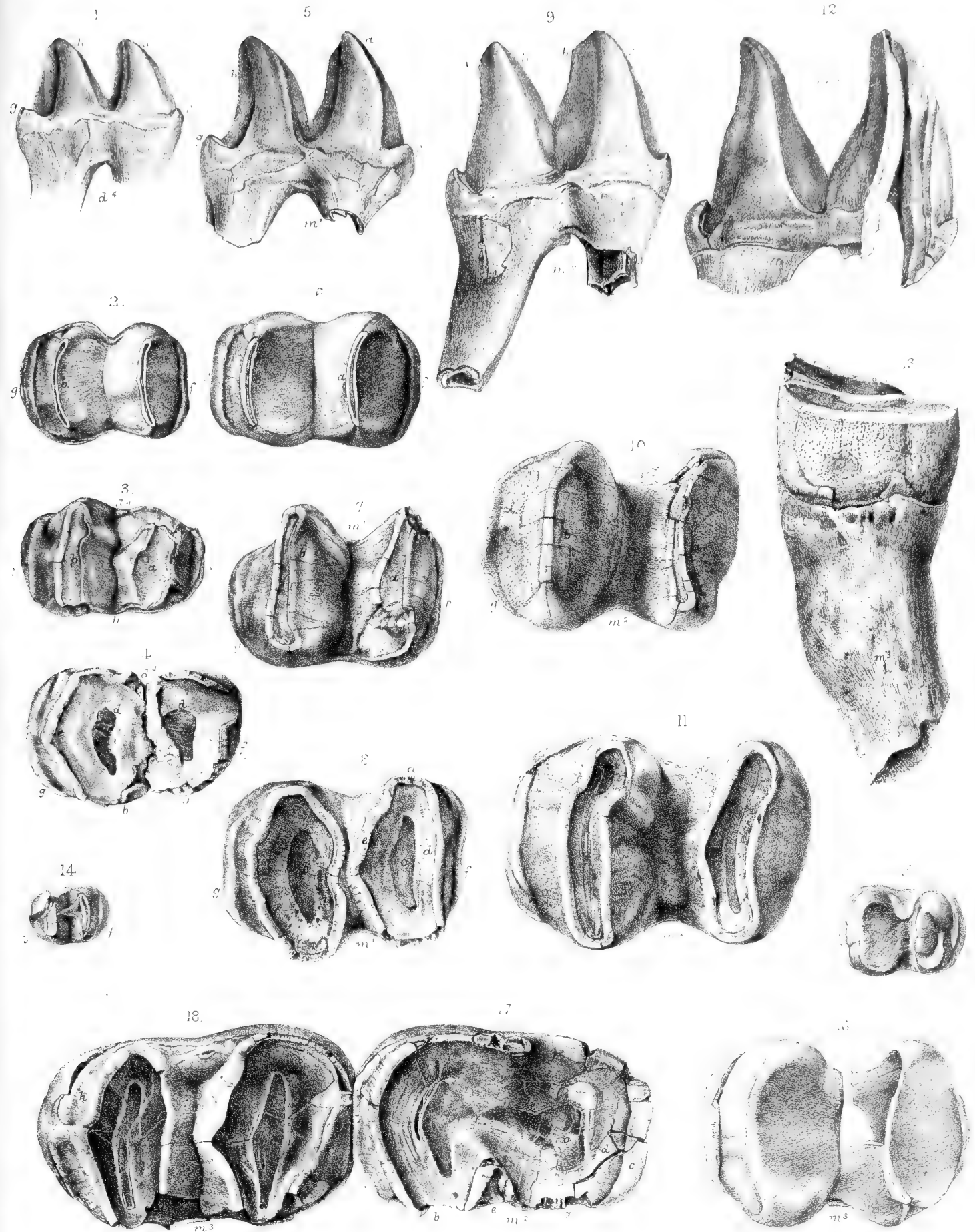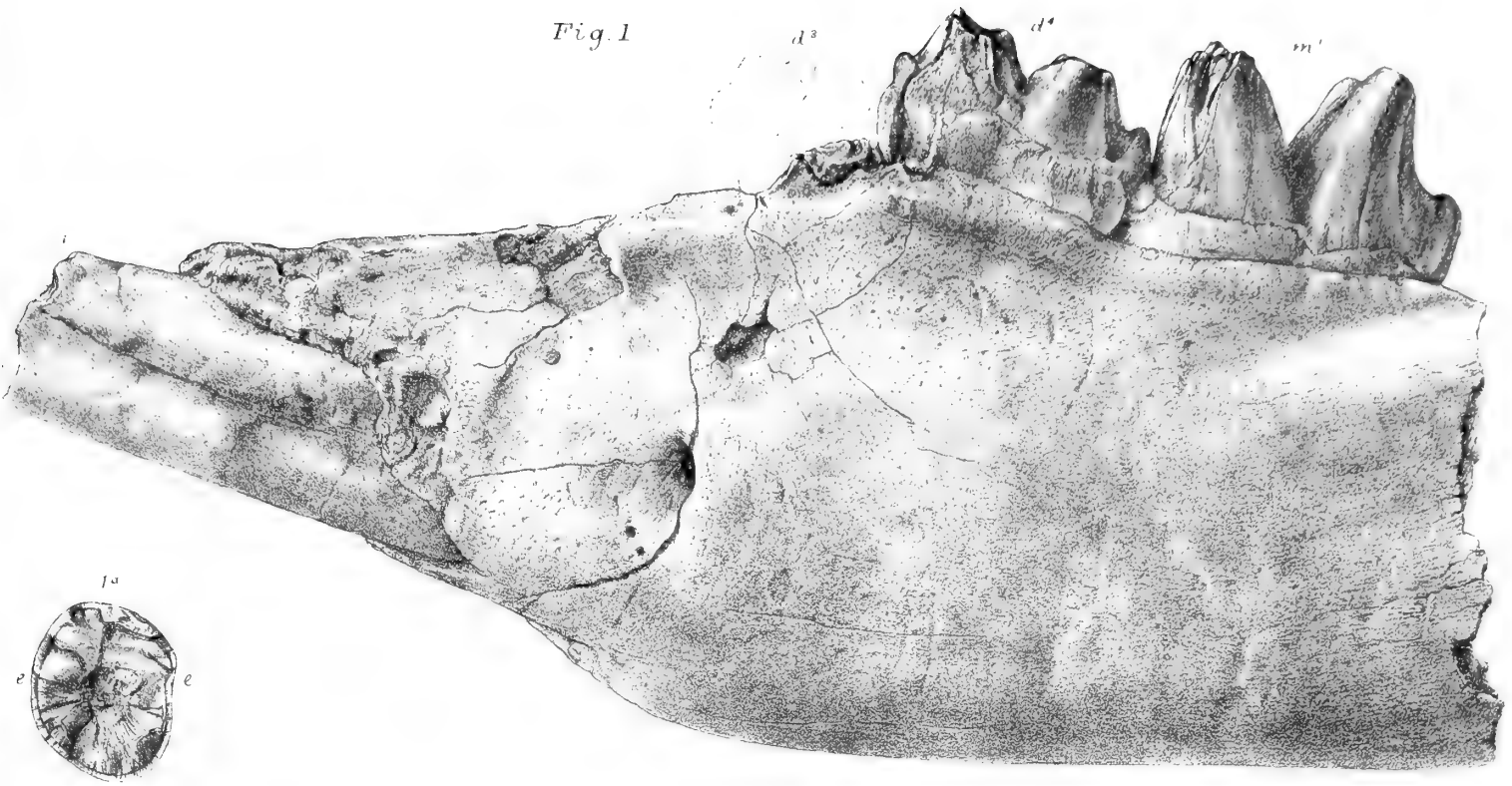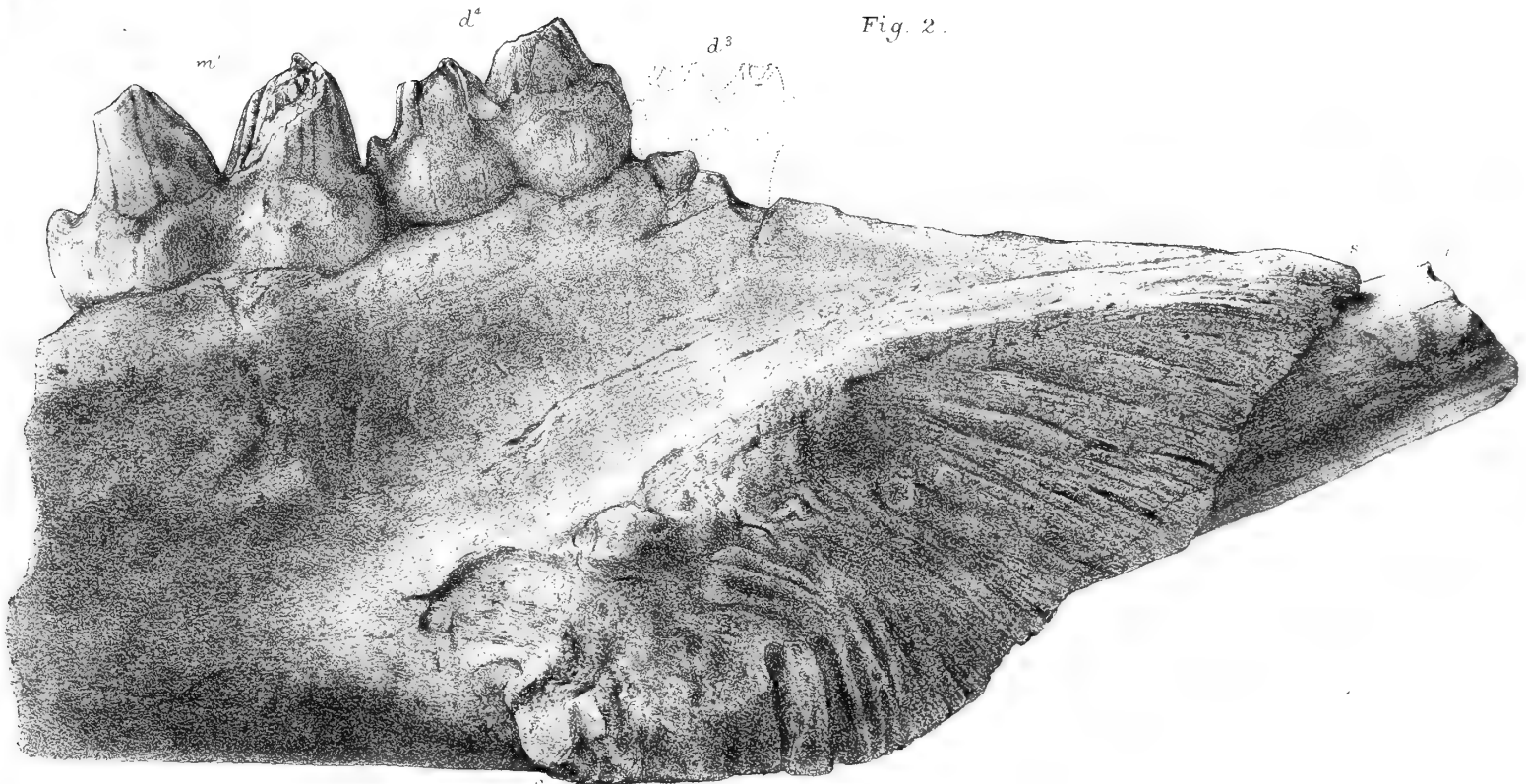
Fig 1

Fig 3

Fig 4

Fig 2

Fig 5

Fig. 1

Fig. 2

4.

1

2.

3.

5.